VOL. 33, NO. 11 NOVEMBER, 1956

AMERICAN JOURNAL OF OPTOMETRY *and* ARCHIVES *of* AMERICAN ACADEMY OF OPTOMETRY

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Published Monthly by the AMERICAN JOURNAL OF OPTOMETRY PUBLISHING ASSOCIATION, 1508 Foshay Tower, 821 Marquette Ave., Minneapolis 2, Minn.

ANNUAL SUBSCRIPTION, UNITED STATES and CANADA $7.00. FOREIGN $7.50.
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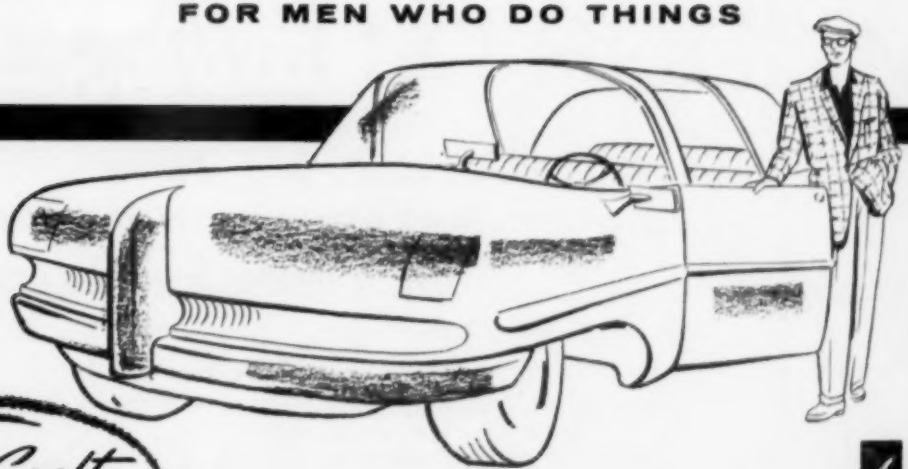

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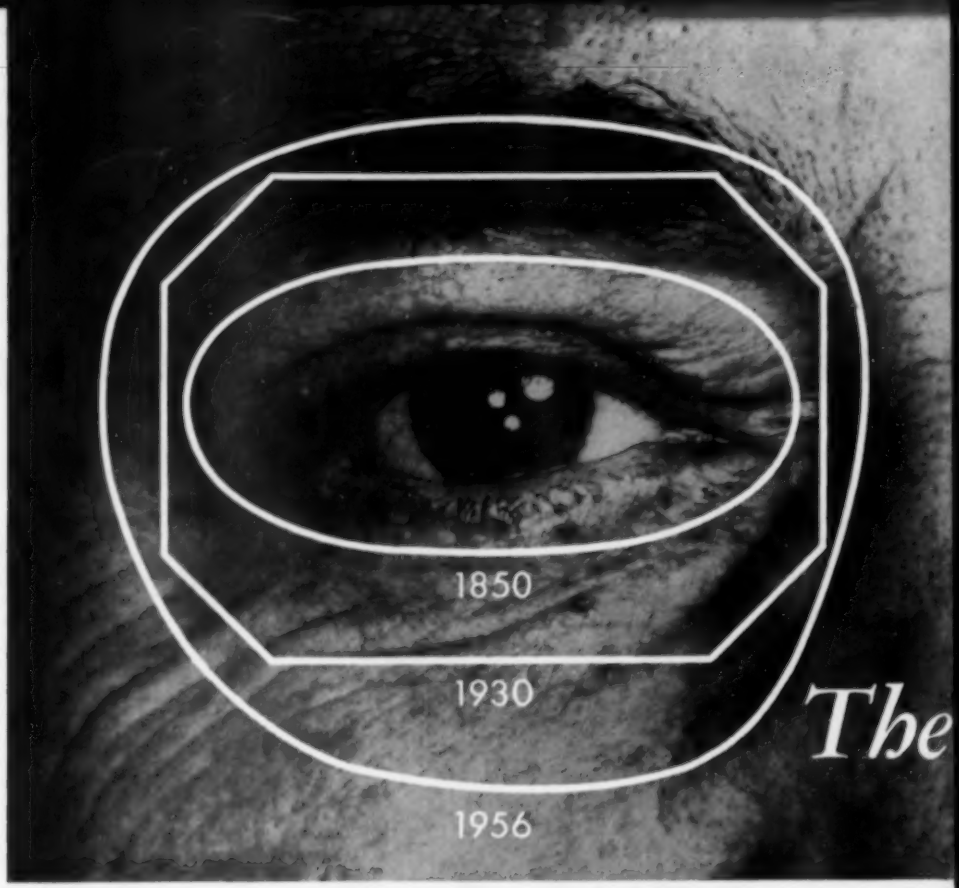

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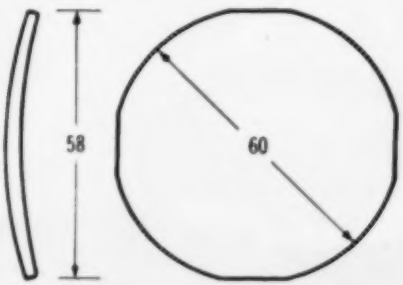

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IOWA				
Des Moines	Tue. Oct. 16	7-10 p.m.	A	Hotel Savery
Sioux City	Tue. Oct. 16	7-10 p.m.	A	Hotel Martin
Davenport	Wed. Nov. 7	7-10 p.m.	A	Hotel Blackhawk
NEBRASKA				
Omaha	Wed. Oct. 17	7-10 p.m.	A & B	Hotel Fontenelle
KANSAS				
Kansas City	Fri. Oct. 19	7-10 p.m.	A & B	The Town House
Wichita	Sun. Oct. 21	1-5 p.m.	A & B	Hotel Lassen
OKLAHOMA				
Oklahoma City	Mon. Oct. 22	7-10 p.m.	A & B	Oklahoma-Biltmo
Tulsa	Tue. Oct. 23	7-10 p.m.	A & B	The Mayo
ILLINOIS				
Peoria	Tue. Nov. 6	7-10 p.m.	A	Hotel Pere-Marqu
Rockford	Thur. Nov. 8	7-10 p.m.	A	Hotel Lafayette
Springfield	Tue. Nov. 13	7-10 p.m.	A & B	Abraham Lincoln
Chicago	Sun. Nov. 18	1-5 p.m.	A & B	Morrison
WISCONSIN				
Milwaukee	Fri. Nov. 9	7-10 p.m.	A & B	Hotel Schroeder
Madison	Fri. Nov. 9	7-10 p.m.	A	Hotel Loraine
MISSOURI				
St. Louis	Wed. Nov. 14	7-10 p.m.	A & B	Statler
INDIANA				
Evansville	Thur. Nov. 15	7-10 p.m.	A & B	Hotel McCurdy
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Jersey City	Fri. Oct. 19	7-10 p.m.	A	Hotel Plaza
Trenton	Thur. Oct. 11	7-10 p.m.	A	Hotel Stacy Trent
Paterson	Wed. Oct. 24	7-10 p.m.	A	The Alexander Ha
MARYLAND				
Baltimore	Tue. Oct. 9	7-10 p.m.	A	Lord Baltimore
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Wilmington	Wed. Oct. 10	7-10 p.m.	A	Hotel DuPont
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MASSACHUSETTS				
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Boston	Fri. Dec. 7	7-10 p.m.	A & B	Sheraton-Plaza
RHODE ISLAND				
Providence	Fri. Nov. 16	7-10 p.m.	A	Sheraton-Biltmore
PENNSYLVANIA				
Philadelphia	Tue. Dec. 4	7-10 p.m.	A & B	Bellevue-Stratford
NEW YORK				
New York City	Wed. Dec. 5	7-10 p.m.	A & B	Barbizon-Plaza
NORTH CAROLINA				
Winston Salem	Sun. Dec. 9	1-5 p.m.	A & B	Hotel Robert E. Le
GEORGIA				
Savannah	Mon. Dec. 10	7-10 p.m.	A & B	Hotel DeSoto
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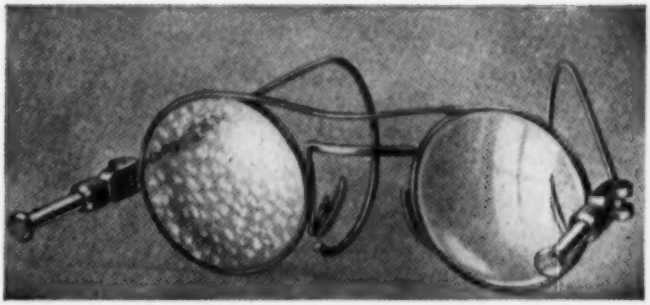

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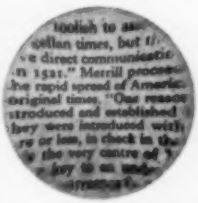

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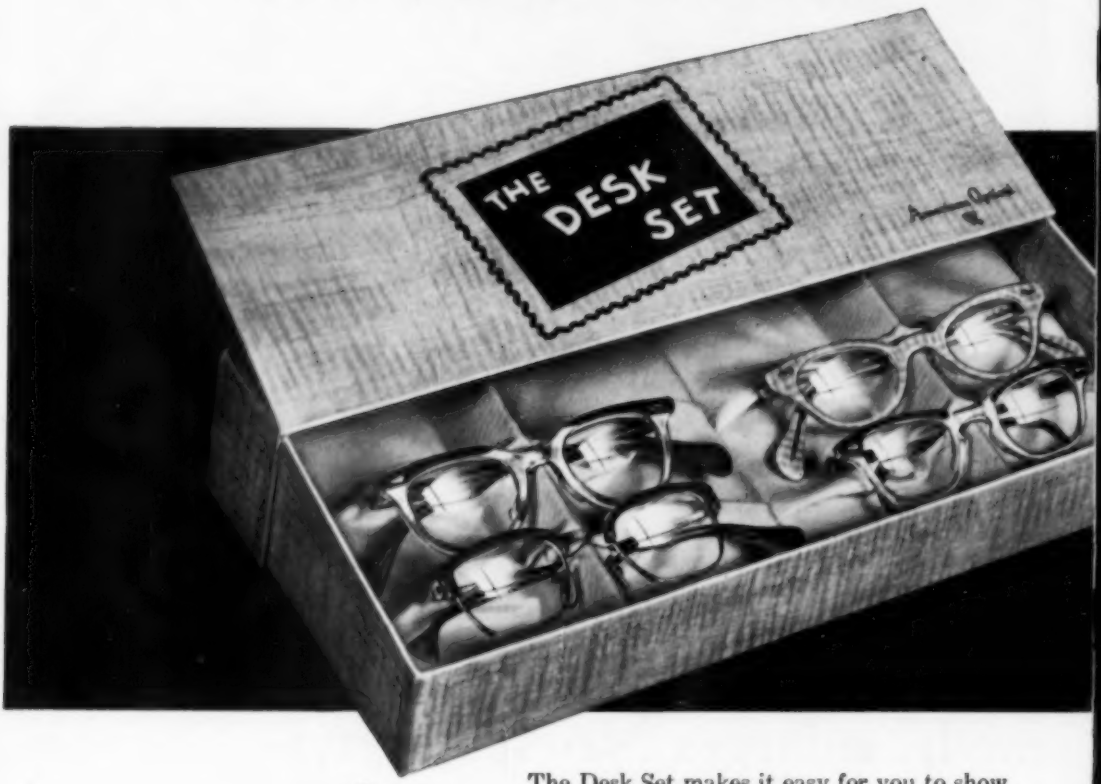

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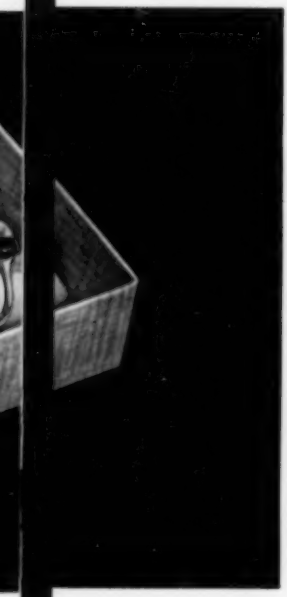

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Vol. 33 November, 1956 No. 11

COMPONENTS OF ACCOMMODATION*

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School of Optometry, University of California
Berkeley, California

AN ANALYSIS OF CONVERGENCE

To promote clearer understanding of the complex function of convergence, Maddox[1] analyzed total convergence into four components**. (1) tonic convergence, (2) accommodative convergence, (3) proximal or "psychic nearness" convergence, and (4) fusional or reflex convergence. The individuality and the specific nature of these components has been questioned from time to time, but the basic concept of a division of total convergence into several separately acting parts has become so widely accepted that the components themselves are occasionally referred to as fundamental physiological functions.

That the components of convergence are either "fundamental" or, strictly speaking, physiological "functions," is rather doubtful. They are usually thought of either as angular portions of the total convergence angle or as portions of the innervation to a group of cooperating muscles, but a point that is frequently overlooked is that the components represent an analysis of the stimulus quite as much as an analysis of the response. This is to say that at the time that these concepts were developed one could not have assayed a convergence measurement without first having analyzed the stimulus; indeed, it was by varying the conditions of the stimulus, noting the effect on convergence, and analyzing the

*Read before the annual meeting of the American Academy of Optometry, Toronto, Ontario, Canada, December 13, 1954. From a thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Physiological Optics. For publication in the November, 1956, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

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**Maddox actually treated convergence as composed of three components, which he called (1) tonic convergence, (2) accommodative convergence, and (3) reflex or fusion convergence; but in an appended note he acknowledged the existence of a fourth component which he designated as "convergence due to 'knowledge of nearness' or in other words, 'voluntary convergence,'" and which he included with accommodative convergence in his principal discussion.

nature of the stimulus variation, that Maddox was able to demonstrate the composite character of the convergence function.

Since the analysis of convergence is concerned to a large extent with the classification of stimuli, it is best considered as an *operational* analysis of convergence measurements. The underlying assumption is that stimuli can be so grouped that each class of stimulus, if acting alone, would produce a characteristic change in convergence. Having analyzed stimuli in this way, the further—and perhaps unwarranted—inference is made that different *kinds* of convergence have been stimulated and measured. Thus, the operational analysis has become a *functional* analysis, leading inevitably to speculation regarding the innervational centers or nervous pathways subserving each function. Perhaps a better interpretation would be that, of the assortment of *adequate stimuli* to convergence, some are more effective than others as producers of convergence movements, and that such stimuli may be grouped according to their effectiveness. Convergence "components" then would represent simply quantitative variations in the response to qualitatively different stimuli, rather than qualitative differences to quantitatively equal stimuli. This analysis avoids the need for hypothetical "centers" or preemptive "pathways" for each of several slightly differing "functions."

Regardless, however, of the philosophy adopted in establishing or applying the results of such an analysis, Maddox's interpretation has proved extremely fruitful in teaching, in experimental investigations, and in analyzing clinical data for the prescribing of lenses or visual training.

ACCOMMODATION

A similar analysis of accommodation (or of accommodative stimuli) is fairly widely recognized, at least among research workers, but has not received the clinical recognition and application which has been accorded the analysis of convergence. Many writers have acknowledged the probable existence of distinct subdivisions of the accommodative process, and others have investigated the characteristics of these subdivisions or components. Clinically, however, accommodation seems most often to be rather vaguely regarded as a single type of response which can be influenced by stimulus conditions, but with little recognition of any clear-cut subdivisions of either the stimulus or the response. It is also, as a rule, considered to be involuntary or reflex in nature, but, to some extent at least, capable of being voluntarily controlled. Though it is almost universally agreed that accommodation is closely associated with convergence, it is also widely believed that accommodation is not directly influenced by changes in convergence.

The lack of any general recognition of specific functional or opera-

tional components within the accommodative process has given rise to conflicting interpretations of experimental findings, and to some controversy even among researchers, regarding the nature of the accommodative function. For example, a problem often considered is that of whether accommodation is a purely reflex action, or in some sense a "voluntary" act, or a combination of voluntary and reflex responses. The matter is apparently not yet settled. Marg[2] investigated voluntary accommodation in a group of young subjects, compared it to reflex accommodation, and concluded that the ability to control accommodation voluntarily is far more common than one would believe from the very few instances cited in the literature. On the other hand, Fincham[3, 4] has reported a striking series of experiments from which he concluded that the whole act of accommodation is involuntary, at least in persons less than 26 years of age.

The viewpoints of Marg and of Fincham are not necessarily as divergent as the statements of their conclusions would suggest. Marg was interested in the magnitude of accommodative changes that could be accomplished by conscious effort, but he was not concerned with the precise innervational pattern that produced the changes he observed. Fincham believes that there are two components involved in the total response. He thinks that convergence is voluntarily initiated in order to fuse disparate images, and that accommodation is governed mainly by a reflex association with convergence. In addition there are smaller, automatic, reflex adjustments of accommodation which are stimulated directly by the vergence of the light reaching the retina. Together these constitute a focusing mechanism with a "coarse" adjustment derived from convergence (therefore, convergence-accommodation), and a "fine" adjustment initiated directly by the vergence of light at the retina (reflex accommodation). The vergence of light can serve as an effective stimulus, Fincham suggests, because of the chromatic aberration of the eye; or because of the directional sensitivity of the retina (Stiles-Crawford effect), although he finds that small scanning movements of the eye are also necessary for reflex accommodation to occur.

Other instances could be cited, where conclusions of two writers appear to be completely at variance, but where each is concerned with a different aspect of accommodation. The very fact that various investigators can talk about "accommodation" and yet not be talking about the same things at all, is a strong hint that accommodation is just as much componential as convergence is. Let us, therefore, consider an analysis of accommodation into functional or operational components which may reconcile such apparently diverse viewpoints. It may also provide

a conceptual framework into which much of our knowledge of accommodation can be fitted to give a more easily grasped, unified picture of accommodative behavior.

Accommodation, then, will be considered in terms of four components which are quite analogous to the components of convergence. They are: (1) tonic accommodation; (2) convergence accommodation; (3) proximal or psychic accommodation; and (4) reflex accommodation. We shall review some of the evidence for the existence of each of these components, taking them in reverse order for convenience.

REFLEX ACCOMMODATION

When a young emmetrope looks through a low-powered negative lens, he will see distant objects clearly. He will also see clearly a target at, say, 40 cm., through low-powered positive or negative lenses. A momentary blur may be noticed when the lens is interposed, but clear vision is restored "automatically" within a fraction of a second. What has occurred between the blurring and the clearing is reflex accommodation.

Reflex accommodation is the only component of accommodation that is directly stimulated by some aspect of the "quality" of the retinal image. It provides an automatic adjustment of the refractive state to maintain a clear and sharply defined image. It is this component of the accommodative response (and its stimulus) which Fincham has studied exhaustively. He finds it to be capable of acting over a range of 2.0 to 2.5 diopters.

Although Fincham believes that reflex accommodation is stimulated by the vergence of light at the retina, the present author has presented evidence against such a theory.[5] Using increasingly blurred targets, it was found that normal observers became more and more incapable of responding to dioptric changes in the stimulus. With maximum blurring, an essentially fixed focus of the eye was maintained. Under these conditions, changes in the vergence of light from the target evoked no change in accommodation, which is to say that blurring-out of the target completely eliminated reflex accommodation. It seems probable that reflex accommodation is a response to the contrast gradients within the image. Blurring reduces these gradients and consequently reduces the stimulus to reflex accommodation.

An almost complete absence of reflex accommodation has been demonstrated in observers afflicted with typical total color blindness.[6] One of the characteristics of typical achromasy is low visual acuity, approximately 20/200. Such observers, then, would benefit little from the precise focus afforded by reflex accommodation as it operates in the normal observer, so it is not surprising to find this component miss-

ing or inactive in subjects with subnormal vision.

In many investigations of accommodation, the efficiency and importance of the reflex component has gone unrecognized. When a target containing fine details is used for fixation, reflex accommodation by itself can hold accommodation steady, at least within the depth of field, obviating changes which would otherwise be effected by other accommodational factors. The investigator looking for such factors (or components) may wrongly conclude that they do not exist.

PROXIMAL OR PSYCHIC ACCOMMODATION

The effects of judgment of target distance upon convergence and accommodation have been investigated a number of times in recent years. It is generally agreed that convergence is influenced by the apparent nearness of the target, but it is less certain that a proximal effect upon accommodation occurs.

Hofstetter[7] measured accommodation and convergence with targets at various distances, and found a sizable proximal effect upon convergence but none upon accommodation. He concluded that the failure to show proximal accommodation was probably because his observers were experienced and expert. However, his targets contained fine details so that reflex accommodation, taking charge so to say, may have left nothing for a proximal component—even though effectively stimulated—to do.

Ittelson and Ames[8] found that by changing the size of a stationary target they could alter its apparent distance and evoke changes in accommodation and convergence. It has since been argued[9] that the change in convergence did not represent proximal convergence, but was actually accommodative convergence. The primary change (in accommodation), therefore, assuredly represented proximal accommodation due to the apparent approach of the test object.

Another effect attributable to proximal accommodation is the overaccommodation shown by inexperienced observers using telescopes, ophthalmoscopes, microscopes, binoculars, or other optical devices. Such an effect is familiar to optical engineers as "instrument effect," "tube effect," etc. Most experienced observers are better able to inhibit accommodation fully, and the inexperienced may overcome most of the effect by consciously thinking of "looking at distance."

Fincham[4] has suggested that awareness of nearness of the object of regard initiates a voluntary adjustment, primarily of convergence, which then causes a corresponding change in accommodation. Allen[10] has shown that the more prompt appearance of convergent movements is really due to the longer latent period of the ciliary muscle as compared

with that of the extra-ocular muscles, and that innervation is probably initiated to convergence and to accommodation simultaneously.

A number of studies of the proximal components of convergence and accommodation have indicated that while the effects are not entirely subject to the observer's volition, some measure of voluntary control must be possible. Certainly an observer can not only voluntarily cross his eyes, but can blur the image of a distant object, by merely thinking of a very near object—"looking" at the bridge of his nose, for example. This would suggest that the voluntary accommodation investigated by Marg was only a great exaggeration of this proximal component, the observer merely "thinking of near" in order to elicit large accommodative changes. The thinking was voluntary, but the subsequent accommodation was automatic.

CONVERGENCE ACCOMMODATION

Although convergence accommodation has often been distinguished as a possible separate kind of accommodative response, most experimental attempts to demonstrate it have been unsuccessful. The principal difficulty has been in allowing freedom for accommodation to change while controlling convergence with a fixation target. A fixation target will ordinarily reduce or prevent changes in accommodation: for, if the target should start to become blurred, this acts as a stimulus to reflex accommodation to re-sharpen the image, thereby restoring the previous refractive status.

It is commonly noted that near the limits of a measurement of relative convergence, accommodation will change enough to blur the target, but the usual explanation for this is that accommodation is being altered to bring more (accommodative) convergence into play in the interest of maintaining single vision. Adamson and Fincham,[11] however, showed that, within the whole amplitude of accommodation, it is impossible to alter convergence without causing some change in accommodation in the same direction. Such change, although presumably *due to* convergence accommodation, would not express the whole magnitude of the convergence accommodation because of the masking action of reflex accommodation.

Two investigators, Fincham[3] and Morgan,[12] have recently reported successful measurements of convergence accommodation. The former used an optical system which limited the light rays entering each eye to an aperture 0.5 mm. in diameter imaged in the plane of the pupil. This so greatly increased the depth of focus that the retinal images of the fixation target remained subjectively sharp regardless of the state

of accommodation. Accommodation was measured with a Fincham Coincidence Optometer. Fincham found that changes of convergence in orthophoric subjects induced changes in accommodation by an amount consistent with the convergence, i.e., one meter angle of convergence induced approximately one diopter of accommodation. In exophoric subjects, larger changes in accommodation were observed; in esophoric subjects, smaller ones.

Morgan measured his own convergence accommodation on a haploscope, viewing green fixation targets through 1 mm. pinholes in red filters in order to increase the depth of field. Although Morgan is himself exophoric, his convergence accommodation amounted to 1 D/15Δ or 1 D/14Δ, so that he resembled Fincham's esophoric subjects. Morgan's ACA ratio, 4.2Δ/1 D., is vastly different from his CAC ratio—his convergence accommodation to convergence ratio.

It seems clear, then, that convergence can act as a stimulus to accommodation. Its relative importance in determining the state of accommodation is difficult to assess, but would appear not to be great, since the stimulation of reflex accommodation (usually present) may act so easily and effectively to reduce or forestall accommodative changes which would otherwise result from convergence changes. Nevertheless, Fincham believes the amount of convergence to be the main or "coarse" determinant of accommodation, at least in binocular vision.[3]

TONIC ACCOMMODATION

If a "relaxed" eye—one receiving no specific innervation to cause it to focus upon an object in the visual field—should tend to adopt and maintain a particular state of accommodation other than zero, this might be considered to represent the effect of tonic accommodation, just as the distance heterophoria is considered to represent the effect of tonic convergence.

A phenomenon intensively studied in recent years points directly, in just this way, to the existence of a tonic component of accommodation. This phenomenon is "nocturnal myopia" or "night myopia," so called because of an apparent increase in the refractive power of the eye under conditions of greatly reduced illumination. Although it has been shown that the spherical and chromatic aberrations of the eye contribute to the apparent increase in power,[13-18] numerous studies have shown that an actual change in accommodation also occurs.[17-22] The amount of this change varies with the individual and the experimental conditions, but seems to average about 1 D. in extremely low illumination or total darkness.[17-22]

The mechanism which might give rise to such a change in the

accommodative status of the eye has not yet been completely identified, but a number of investigators have contended that the scotopic status represents the true resting condition of the eye,[20, 21, 23] i.e., that accommodation is truly relaxed under these conditions, and that the refractive state exhibited under ordinary photopic conditions is *not* a relaxed state but is the result of "negative accommodation," an active flattening of the crystalline lens.[24] The analysis here proposed would make tonic accommodation responsible for the accommodative portion of night myopia. What seems to be "negative accommodation," overcoming this in the normal photopic refractive state, is actually reflex accommodation acting in response to the detail of a distant target. It must be borne in mind that reflex accommodation can not only increase the refractive state for an approaching target but can also reduce it for a receding one. What to call "positive" reflex accommodation, and what to call "negative," will depend upon the nature of the physiological "zero."

Tacit in the numerous investigations of nocturnal myopia was the assumption that it was the low level of luminance that was of basic importance in the phenomenon. However, it has been shown[5] that the phenomena of "night" myopia and "night" presbyopia could be duplicated under photopic conditions by suitably blurring the fixation target. Viewing increasingly blurred targets, normal observers showed a progressive loss of accommodative amplitude and finally, with maximum blur, assumed a relatively *fixed* focus at a refractive level of about 1 D.

Knoll[25] has called attention to a number of other investigations[26-29] which similarly have revealed an increased refraction under photopic conditions when blurred targets were used. This appears to be the same effect which has caused fliers and ground observers to report difficulty in detecting aircraft against a homogeneous sky background. Because of their tendency to accommodate for some relatively short distance, the phenomenon has aptly been termed "space myopia" or "sky myopia." Investigations of sky myopia have similarly shown an average of about 1 D. of accommodation.[30]

In these various investigations, when visual acuity was effectively decreased, whether by blurring or by reducing illumination, accurate positioning of accommodation became pointless, for the appearance of the field could scarcely be altered by even very large accommodative changes. Consequently reflex accommodation was rendered ineffective and tonic accommodation became more important in determining the refractive state. In the ultimate case of a homogeneous visual field—the sky, or total darkness—tonic accommodation remained as the only active component of accommodation, and the refractive state could then reveal

the full extent of this component.

These findings support the idea of a position of "rest" or "poise" for the accommodative mechanism which does not correspond to the photopic refraction as normally determined (the "static" refraction), but to a state 0.75 to 1.25 D. more myopic. To see clearly at distance under normal conditions would then require the exertion of "negative accommodation."* Though we are not concerned here with the nervous pathways associated with the various components, it has been suggested that negative accommodation could be brought about by action of the sympathetic nervous system,[26, 31] or by inhibition of parasympathetic "tonicity"[28] (or activity). Stoddard[32] has summarized the evidence for dual innervation of the ciliary body which would permit either or both actions to occur, and has discussed the effects of autonomic stimulation upon the refractive state. Morgan[33] has suggested that the effect of the sympathetic is to establish a "base-line" or basic refractive state, and that normal accommodative changes are superimposed upon this basic refractive state entirely by way of parasympathetic innervation.

SUMMARY

Some of the evidence for an operational analysis of accommodation into four components, similar to the components of convergence, has been assembled and reviewed. The components (1) tonic accommodation, (2) convergence accommodation, (3) proximal or psychic accommodation, and (4) reflex accommodation act together to modify the refractive state of the eye. The individual importance of each in determining the total accommodative response varies with the circumstances and particular conditions under which an accommodation stimulus is presented, but reflex accommodation appears generally to be the most potent. The action of the other components can, however, be observed in many situations, and several of these have been cited.

This analysis leads to the suggestion that in the so-called emmetropic eye or in the "corrected" ametropic eye, the accommodative mechanism is not truly relaxed when distant targets are being observed. Tonic accommodation tends to return the eye to a myopic state, but is largely prevented from doing so by the action of reflex accommodation in response to the contrast of the resolvable detail of the distant target, and perhaps partly also by the action of psychic accommodation stemming from awareness of the distance of the target. Available evidence

*Reflex accommodation acting to reduce the refractive power of the eye. The amount of this negative reflex accommodation would be somewhat less than the amount of the "resting myopia" because of the depth of focus of the eye, which would permit maximum resolution of distant targets when the true focus of the eye was still about 0.5 D. myopic.

would indicate, however, that psychic accommodation probably does not act to any valuable extent in such a situation, but is instead more important in the response to near objects, as is convergence accommodation. An emmetropic refractive state is achieved, therefore, as the result of a maximal flattening of the crystalline lens by reflex accommodation, and this would occur only in a subject whose truly relaxed state of accommodation is one of slight myopia. The "plus-bias" of modern refracting procedures ensures that this condition will prevail also in the corrected ametropic eye.

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MATERIALS AND EQUIPMENT

The Bausch & Lomb Optical Company have introduced a small new table-top School Ortho-Rater with special slides for measuring the visual performance of those very young students who have not yet learned the alphabet. The students report orally what they see to the individual supervising the screening.

The Keystone View Company have introduced a new visual training series of slides called the Adult Eye Comfort Stereographs for home visual training programs. For further information on these new home training slides write to the Keystone View Company, Meadville, Pennsylvania.

The Armco Mercantile Company have introduced a new telescopic spectacle loupe with 2X and 3X powers. These are available in both metal and zyl mountings. A Brochure on these new magnifiers may be had by writing the Armco Mercantile Company, 221 N. LaSalle St., Chicago 1, Illinois.

AN ANALYSIS OF REFERRALS BASED ON SCHOOL VISION SCREENING TESTS*

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Following brief notes on the general outcomes of the Danbury Study,[3] this report provides additional information concerning the children who failed the vision screening tests and were referred for professional attention. As part of the analysis, the test performances of children wearing glasses are compared with those of children who do not have glasses; similarly, the diagnoses and treatments reported for new referrals are compared with those reported for children under care when the study was initiated.

THE STUDY

During the 1951-1952 school year, 4,662 children from kindergarten through grade twelve were tested with an experimental model of the Massachusetts Vision Test. Children were considered to have failed the test if:

1. Acuity at 20 feet was less than 20/20** for either the right or the left eye.
2. Acuity at 20 feet through plus sphere lenses (+ 1.75 D. S. for grades 1 and 2, + 1.50 D. S. for grade 3 and above) was (a) 20/20** for either the right or the left eye or (b) 20/30** for both the right and the left eyes.
3. Vertical phoria or tropia at 20 feet was greater than 1.25Δ.
4. Lateral phoria or tropia was greater than 6.0Δ "eso" or 4.0Δ "exo" at 20 feet, or greater than 6.0Δ "eso" or 8.0Δ "exo" at 16 inches.

Following these standards, children wearing corrections were tested through their lenses; those who did not possess glasses were tested in the usual manner. To assure a high degree of accuracy in the identification of failures, those who failed the first test were retested and, thus, given a second opportunity to perform at the levels established for passing.

TEST RESULTS

The screening test results are summarized in Table 1. In the

*Read before the annual meeting of the American Academy of Optometry, Chicago, Illinois, December 12, 1955. For publication in the November, 1956, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

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**The criterion for acuity test performances was the correct reading of at least 4 of the 6 letters presented.

TABLE 1
SUMMARY OF TEST RESULTS

Group	Number	Per Cent Failure First Test	Per Cent Failure Test & Retest
Children Wearing Glasses	575	55.8	44.9
Children Who Did Not Have Glasses	4,087	20.4	11.7

group of 575 children wearing glasses, 55.8 per cent failed the first test; about 44.9 per cent failed both test and retest. In the group of 4,087 children who did not have glasses, 20.4 per cent failed the first test; about 11.7 per cent failed both test and retest.

These data present two findings of major interest. One concerns the relatively poor performance of children wearing corrections and tested through their lenses. The other concerns the frequency with which screening test performance changed from "fail" to "pass" on retest.

Considering the proportions failing both test and retest shown in the right-hand column of Table I, it is apparent that the failure for children examined through the lenses worn, 44.9 per cent, is nearly four times the rate for children who do not possess glasses, 11.7 per cent. The magnitude of the difference indicates that, despite the improved vision attained through the use of corrective lenses, many children wearing glasses do not achieve the visual performance required to pass screening tests. Furthermore, as a group, children wearing glasses do not demonstrate visual proficiency comparable to that of children who do not have glasses.

Although it is assumed sometimes that children with glasses have "good" vision, the data indicate that a considerable number of these children have visual deficiencies which cannot be corrected fully or for which full correction may not be desirable. Many do perform at the levels established for screening purposes showing, for practical purposes, no visual deficiency. There are, nevertheless, significant numbers whose glasses seem to provide essential amelioration of visual difficulties but not necessarily "normal" vision.

The degree of the residual handicaps among children wearing glasses who do not meet screening test requirements is not revealed by the screening test data. In all probability, some have deficiencies such that they cannot compete visually with others who wear glasses or whose vision is good without correction. It would seem advisable, therefore, that teachers and parents be informed concerning children whose corrected vision is not entirely satisfactory, especially if the deficiency is such that some action to aid vision is indicated at home or at school.

Returning to Table 1, we may examine the information on the rate of change from "fail" to "pass" on re-examination for both the children wearing glasses and the children without glasses. When the base of reference is the number of children shown in the first column, the difference between the two groups appears negligible. The proportion failing the first test and passing the retest is 55.8 — 44.9 or 10.9 per cent of the children wearing glasses and 20.4 — 11.7 or 8.7 per cent of the children without glasses. The difference of about 2 per cent is not very large. On the other hand, if we consider the proportion of the first test failures that pass the retest, a marked difference between the groups appears.

The first test failures passing the retest may be estimated at $\frac{10.9}{55.8}$ or about 20 per cent for children wearing glasses and $\frac{8.7}{20.4}$ or about 43 per cent for children who do not possess glasses. Accordingly, the probability that a failure on the first test would pass the retest is roughly one in five for children wearing glasses and slightly more than two in five for children who do not have glasses.

Many factors may be expected to influence the tendency for a child to fail the first test and pass the second test. It seems very likely, however, that the difference between the two groups is a function of the distributions of visual skills in relation to the critical points established to distinguish between passing and failing test performances. In the visual acuity tests, for example, the screening routine utilizes a critical point, the reading of at least 4 of 6 20/20 size test letters, to distinguish between the children who pass and the children who fail. Under these circumstances, the frequency with which individuals in any given group might be expected to change performance from test to retest would be influenced considerably by the number whose vision is approximately that defined by the ability to read 4 of 6 20/20 letters and whose performance might vary by chance above or below this critical point.

In view of the standardization of test procedures, it is reasonable to assume that the changes in performance from fail to pass on retest are in large degree a matter of chance variation. Unfortunately, the hypothesis that the frequency of these changes in any group is a function of the number of individuals with vision near the critical points cannot be verified in the absence of data showing detailed distributions of acuity and other functions. Nevertheless, the high failure rate and the low rate of change from fail to pass on retest for children wearing glasses are con-

sistent with the hypothesis that relatively fewer individuals in the group have vision close to the critical points. Similarly, the lower failure rate and the high rate of change from fail to pass on retest for children without glasses are in accordance with the expectation that relatively more individuals have vision close to the critical points. It is suggested, therefore, that the contrasting 20 per cent to 43 per cent difference between the two groups in the frequency with which first test failures pass the retest is a function of the proportion of children in each group with vision close to the critical points used to distinguish between the failing and passing performances.

Although the test performance data are of interest, the purpose of screening is to provide better visual health care for school children. The steps taken in the Danbury project may be described as twofold. First, inquiries were made to determine the visual care status of children known to have had professional attention. Second, children not under care who failed the test were referred for a visual examination.

INQUIRIES.

For children wearing glasses or otherwise known to be under care, the screening test results were disregarded. Inquiries were made to determine the current visual care status of each child. Letters sent to the parents requested that a second form be forwarded to the doctor who last examined the child's eyes. The doctors returned to the study office 359 report forms, 58.8 per cent of inquiries mailed to the parents of children under care.

One item of information requested was the date of the last examination. Although the purpose of the question was to reveal the age of the prescriptions worn at the time of the screening project, the information obtained was not entirely satisfactory. In many instances, the inquiry served as a reminder that a re-examination was overdue. Action was taken and, consequently, many reports noted an examination date which followed the inquiry and did not reveal the date of prescription worn at the time of the screening test.

Another item of general information concerned the desirability of re-examination. The reports indicated that re-examinations were desirable for 42.9 per cent of the children under care and that re-examinations were arranged for 29.4 per cent as a result of the inquiry alone. When a doctor indicated that a re-examination was desirable but not arranged, the parent concerned was notified. Unfortunately, no data were gathered to determine the effect of these special notices. It is of special interest, however, that the inquiry procedure alone resulted in re-

examinations for 29.4 per cent of the children, a significant portion of the 42.9 per cent the doctors considered to be in need of a re-examination. In view of this finding, the inquiry routine would appear to be a very effective approach to the problem of maintaining the visual care status of school children through periodic examinations.

REFERRALS

For children who did not have glasses and who failed the screening test, a letter was mailed to parents recommending that a visual examination be arranged and requesting that an enclosed form be presented to the eye doctor at the time of the examination. These referral letters were mailed to 501 parents; 259 or 51.7 per cent of the report forms were returned to the study office by the doctors.

In order to evaluate the referrals made, it was essential to determine the general outcomes of the doctor's examination for each child. This information was provided by one set of questions regarding the need for care and one set of ratings on the quality of the referral.

To the question "Did your examination reveal a need for visual care?" there were 257 replies: 73.2 per cent "Yes," and 26.8 per cent "No." For the children found not to need visual care (26.8 per cent "No"), two additional questions were asked:

1. "Was the complete eye examination desirable at this time?"
   65 replies: 80.0 per cent "Yes"
   20.0 per cent "No"
2. "Were any signs of visual deficiency detected?"
   62 replies: 69.4 per cent "Yes"
   30.6 per cent "No"

The responses to these questions were supplemented by 241 ratings in which the referrals were checked as "fully warranted," "very appropriate," or "unnecessary." The distribution of these ratings as defined was:

71.8 per cent—Visual care needed
22.8 per cent—Professional attention indicated
5.4 per cent—No visual deficiency

Of crucial importance to any school vision screening operation is the extent to which the doctors find the children referred to be in need of visual care. These ratings provide relevant information, but the statistics vary with the criterion adopted to define and designate a "correct" referral. Using as a criterion the immediate need for visual care, 72 per cent of the referrals were correct; 28 per cent, in error. On the other hand, using as a criterion either the need for visual care or the

doctor's opinion on the need for professional attention, 95 per cent of the referrals were correct: only 5 per cent, in error. In view of the frequently mentioned over-referral problem, the outcome by either criterion seems favorable. It seems likely that, following the procedures of the Danbury Study, there is need to be concerned relatively more with errors of under-referral and relatively less with errors of over-referral.

With these notes on the general outcomes of the study, it is feasible to proceed with more detailed analysis of the test results and other findings. In so doing, one encounters a somewhat relentless diminution in the quantity of data available. Beginning with a sample of 4,662 school children, it might appear that data would be available for an ample number. On the other hand, when consideration is given to selected groups of individuals, for example, those children (a) who were not under care, and (b) who failed the plus lens test and (c) for whom a diagnosis is available, the numbers may be drastically reduced. Proceeding with an appropriate degree of caution, however, some interesting and significant trends may be observed.

PARTS OF SCREENING TEST FAILED

The test routine included a sequence of seven tests: 1A, right eye acuity; 1B, left eye acuity; 2A, right eye acuity through plus lens; 2B, left eye acuity through plus lens; 3, hyperphoria at twenty feet; 4A, lateral phoria at twenty feet; 4B, lateral phoria at sixteen inches. Following this pattern, the test first failed is, for screening purposes, sufficient for the decision to refer a child for a complete visual examination. Accordingly, there is a sequential elimination of failures. Children tabulated as failing any given test passed all the preceding tests and did not have an opportunity to fail any subsequent test. In the tables which follow, failures are grouped in three categories: (1) Acuity (tests 1A and 1B), (2) Plus lens (tests 2A and 2B), and (3) Muscle balance (tests 3, 4A, 4B). These constitute the parts of the test to be discussed.

Table 2 presents the percentage distributions for 646 children who

TABLE 2
PARTS OF RETEST FAILED

Group	Number Failed	Per Cent of Failures: Acuity	Plus Lens	Muscle Balance
Children Wearing Glasses	227	93.8	0.4	5.7
Children Who Did Not Have Glasses	419	70.1	16.0	13.9

failed the retest. The 227 failures among children tested through the lenses worn reveal that 93.8 per cent did not meet the standards for

acuity and 5.7 per cent did not meet the standards for muscle balance. One individual (0.4 per cent) failed the plus lens test but it seems reasonable to consider this an accidental event unlikely to occur except by chance in a group of children wearing corrections. For all practical purposes, failures among children with glasses were distributed as follows: 94 per cent on the acuity tests and 6 per cent on the muscle balance tests.

The 419 retest failures among children who did not have glasses present a very different distribution. The lower line of Table 2 shows that 70.1 per cent failed the acuity test; 16.0 per cent, plus lens test; and 13.9 per cent, the muscle balance tests.

The marked differences between the distribution of failures for children wearing corrections and that for children who do not have corrections support strongly the separate treatment of the two sets of data. The differences between 93.8 and 70.1 in acuity, 0.4 and 16.0 in plus lens, 5.7 and 13.9 in muscle balance tests are so large that it is difficult to conceive of circumstances wherein the two groups could be treated as one. Originally, the two sets of data were separated because of the large difference observed in the failure rate; the findings on the parts of the test failed provide additional evidence that the data should not be pooled.

The failures among children wearing glasses are predominantly in the visual acuity test; only a small proportion fail the muscle balance tests. A majority (70 per cent) of the failures among children who do not have glasses were in visual acuity, but approximately 30 per cent were distributed between plus lens and muscle balance tests. Considering the number of children involved, these findings may be taken as reasonably representative of the outcomes when the same testing procedures are followed in a community like Danbury.

Unfortunately, efforts to compare the distributions presented in Table 2 with others reported in the literature do not yield satisfactory results. Other data were gathered under conditions wherein the standards for failures, the retest procedures, and the testing practices for children wearing glasses are not comparable. Since a discussion of differences in screening practices as well as differences in the distributions obtained would exceed the scope of this report, it may be noted only that other data are available in articles by Sloane,[4] Gutman,[2] Yasuna and Green,[5] and Benton.[1]

REFERRALS BY PARTS OF TEST FAILED

Turning from test data, as such, it is desired to consider the doctors' findings for the children referred for a visual examination. The information presented in the following three sections concerns children (a) who

did not have corrections, (b) who failed both test and retest, and (c) for whom a report from the doctor included replies to specific questions.

THE NEED FOR VISUAL CARE

Replies to the question, "Did your examination reveal a need for visual care?" are shown in Table 3 for 222 referrals by parts of the

TABLE 3
REFERRALS
NEED FOR VISUAL CARE BY PARTS OF TEST FAILED

Need Care? *	Failed		
	Visual Acuity (N = 164)	Plus Lens (N = 25)	Muscle Balance (N = 33)
	%	%	%
"Yes"	73.8	72.0	75.8
"No"	26.2	28.0	24.2
Total	100.0	100.0	100.0

*Doctors' answers to the question: "Did your examination reveal a need for visual care?"

screening test failed. There is little differentiation between the parts failed with reference to the general need for professional care. "Yes" was the reply for 73.8 per cent of the 164 acuity test failures, for 72.0 per cent of the 25 plus lens failures, and 75.8 per cent of the 33 muscle balance failures. Although these proportions of "Yes" responses may be taken as similar for all practical purposes, larger numbers of plus lens and muscle balance failures would be helpful and more convincing.

Accepting the data of Table 3 as representative of larger numbers, however, the three parts of the test appear to be equally effective in identifying children who may be considered "correct" referrals. The likelihood that the doctors would find a given school child to be in need of visual care does not vary by the part of the test failed. Perhaps the most interesting implication of this concerns the question sometimes raised regarding the advisabilty of extending school vision screening beyond the routine acuity test. The evidence suggests that the other tests used here can be as effective as the acuity test in identifying children who need visual care.

Another approach to the evaluation of the need for care may be made in terms of the doctors' ratings of each referral. The data for 211 referrals are presented in Table 4. Among the 155 acuity test referrals, 73.5 per cent were fully warranted: 21.9 per cent, very appropriate: 4.5 per cent, unnecessary. Among the 23 plus lens referrals, 73.9 per cent were fully warranted: 17.4 per cent, very appropriate: and 8.7 per cent, unnecessary. Among the 33 muscle balance referrals, 60.6 per

TABLE 4
REFERRALS
RATINGS BY PARTS OF TEST FAILED

Rating of Referral	Visual Acuity (N = 155)	Failed Plus Lens (N = 23)	Muscle Balance (N = 33)
	%	%	%
Fully Warranted	73.5	73.9	60.6
Very Appropriate	21.9	17.4	39.4
Unnecessary	4.5	8.7	0.0
Total	100.0	100.0	100.0

cent were considered fully warranted; 39.4 per cent, very appropriate; 0.0 per cent, unnecessary.

For the visual acuity and plus lens tests, the proportion of fully warranted referrals is practically identical at about 74 per cent; for the muscle balance tests, the proportion is lower at about 61 per cent. Although the muscle balance test failures received a smaller proportion of fully warranted ratings, none was rated as unnecessary. By contrast, 4.5 per cent of the acuity failures and 8.7 per cent of the plus lens failures were rated as unnecessary.

Of particular interest in connection with the referrals for failure of the plus lens test is the possible differentiation between failures at the 20/20 level, either eye, and failures at the 20/30 level, each eye. The 23 plus lens failures shown in Table 4 included nine children who read the 20/30 letters with each eye separately. The two children whose referral was rated unnecessary are in this group. This might be taken to indicate that the 20/30 level referrals are less likely to be classed as having visual deficiencies needing treatment; on the other hand, six of these nine referrals were rated as fully warranted. Again, the data are interesting but greater numbers are needed to demonstrate trends in a convincing manner.

The ratings for failures on the muscle balance tests follow a slightly different pattern. The absence of "unnecessary" ratings may indicate that, among these referrals, there is clear recognition of existing visual deficiencies; the lower frequency (60.6 per cent) of "fully warranted" ratings may reflect a slightly reduced treatment rate. Relatively speaking, the rating which seems outstanding for children referred for failure of muscle balance tests is "very appropriate" (39.4 per cent), signifying perhaps that professional attention was indicated although visual care was not prescribed. The reality of this trend is, like others, subject to demonstration with larger numbers.

DIAGNOSIS

The forms returned by the doctors provided space in which the diagnoses could be checked as refractive error, phoria, or tropia. The distributions of 186 diagnoses are shown in Table 5 for failures in the visual acuity, the plus lens, and the muscle balance tests.

TABLE 5
REFERRALS
DIAGNOSIS BY PARTS OF TEST FAILED

Diagnosis	Failed Visual Acuity (N = 132)	Failed Plus Lens (N = 23)	Failed Muscle Balance (N = 31)
	%	%	%
Refractive Error	75.8	73.9	12.9
Phoria	4.5	8.7	38.7
Tropia	3.8	0.0	12.9
Refractive Error & Phoria or Tropia	15.9	17.4	35.5
Total	100.0	100.0	100.0

In the group of 132 acuity test failures, 75.8 per cent were diagnosed as refractive errors; 4.5 per cent, as phorias; 3.8 per cent, as tropias; 15.9 per cent, as combinations of refractive error and phoria or tropia. The frequency with which phorias and tropias appear, approximately 23 per cent, indicates that many failures in visual acuity at the 20/20 level might be expected to fail the muscle balance tests also. Under these circumstances, the distribution of failures shown in Table 2 may be subject to considerable variation, particularly if the acuity standard is lowered. The pattern of diagnoses by parts of test failed which appears in Table 5 might be expected to vary also. Following the standards of the present study, however, the acuity portion of the screening test selects for referral some children whose major visual deficiency may be diagnosed as other than refractive error.

The second column of Table 5 shows the per cent distribution of 23 diagnoses for plus lens failures: 73.9 per cent were refractive error; 8.7 per cent, phoria; 17.4 per cent, combinations of refractive error and phoria or tropia. No tropias as such are listed. With this exception, the diagnoses resemble those for failures on the acuity tests. Considering the small number of children, it may be reasonable to accept the distribution of diagnoses for the plus lens failures as practically identical with that obtained for acuity test failures.

The diagnoses reported for 31 failures on muscle balance tests do not follow the same pattern. Only 12.9 per cent are refractive errors. Phorias and tropias are high at 38.7 and 12.9 per cent, respectively.

Phorias or tropias in combination with refractive errors are likewise high at 35.5 per cent. Although the distributions of diagnoses for acuity and plus lens failures may be very similar, the diagnoses for failures on the muscle balance tests are clearly different.

TREATMENT

Table 6 presents the treatments for 152 children failing various

TABLE 6
REFERRALS
TREATMENT BY PARTS OF TEST FAILED

Treatment	Failed Visual Acuity (N = 114)	Failed Plus Lens (N = 15)	Failed Muscle Balance (N = 23)
	%	%	%
Lens Correction	93.0	100.0	30.4
Visual Training	2.6	0.0	47.8
Lens Correction and Visual Training	2.6	0.0	21.7
Surgery	1.8	0.0	0.0
Total	100.0	100.0	100.0

parts of the screening test. Among the 114 referred for failure in visual acuity, 93.0 per cent received lens corrections; 2.6 per cent, visual training; 2.6 per cent, lens corrections and visual training; 1.8 per cent, surgery. All 15 plus lens referrals received lens corrections. A greater quantity of data are needed to reveal the extent to which the treatments for plus lens referrals might resemble those for visual acuity referrals.

The treatments for 23 muscle balance referrals show that 30.4 per cent received lens corrections; 47.8 per cent, visual training; 21.7 per cent, both lens correction and visual training. Expressed in slightly different form, 52.1 per cent received lens corrections only or in combination with visual training; 69.5 per cent received visual training only or in combination with lens corrections. As in diagnoses, the treatments received by children referred for failure of the muscle balance tests differ from those received by children who failed the acuity or plus lens tests.

The relatively small numbers referred for plus lens and muscle balance test failures make caution advisable, but the trends observed may be summarized as follows: (1) The doctors' replies to the question regarding the need for care do not differentiate between children failing different parts of the test. (2) The doctors' ratings on the quality of the referrals do not seem to differentiate between failures on the visual acuity and plus lens tests; the muscle balance failures, however, may tend to receive fewer ratings of "fully warranted" and "unnecessary" and more ratings of "very appropriate." (3) In diagnosis and treatment, there

are no marked differences observed between acuity and plus lens failures; muscle balance failures, however, present contrasting patterns in both diagnosis and treatment.

INQUIRIES AND REFERRALS

The procedures followed make information available for two groups of children who received visual care of some kind. One group, the *inquiries*, is composed of those under care at the time the study was initiated. The other group, the *referrals*, is composed of those who were referred and accepted for treatment during the study.

The sampling of referrals may be considered adequate. With reference to the sampling of inquiries, however, there may be some uncertainty since the best and most easily obtained evidence concerning previous visual care was the fact that a child wore glasses. Under these circumstances, the inquiry group may tend to provide more information on children wearing glasses and less information on those under treatment who do not wear glasses. Allowing for this kind of sampling error, a comparison of data on diagnosis and treatment reported on inquiry and referral forms may be undertaken.

The diagnosis reported for 286 inquiries and 186 referrals appear in Table 7. The inquiries show: 72.0 per cent refractive error, 3.5

TABLE 7

DIAGNOSIS REPORTED ON INQUIRY AND REFERRAL FORMS

Diagnosis	Inquiries (N = 286)	Referrals (N = 186)
	%	%
Refractive Error	72.0	65.1
Phoria	3.5	10.8
Tropia	2.1	4.8
Refractive Error and Phoria or Tropia	22.4	19.4
Total	100.0	100.0

per cent phoria, 2.1 per cent tropia, 22.4 per cent refractive error and phoria or tropia. Among the new referrals, the diagnoses were: 65.1 per cent refractive error, 10.8 per cent phoria, 4.8 per cent tropia and 19.4 per cent refractive error and phoria or tropia. The proportion of refractive errors, as such, and in combination with phorias or tropias are 72.0 + 22.4 or 94.4 per cent for inquiries and 65.1 + 19.4 or 84.5 per cent for referrals. Similarly, the totals of phoria and tropias are 5.6 per cent for inquiries and 15.6 per cent for referrals.

When compared with the children known to have received visual care before the study was initiated, the new referrals show a smaller proportion of refractive errors and a larger proportion of phorias and

tropias. This trend could be accounted for if, in addition to identifying refractive errors, the screening procedure selected for referral phorias and tropias which are not ordinarily encountered among school children who have had visual care.

Treatments received by 327 inquiries and 152 referrals are shown in Table 8. Lens corrections are predominant among the inquiries:

TABLE 8

TREATMENTS REPORTED ON INQUIRY AND REFERRAL FORMS

Treatment	Inquiries (N = 327)	Referrals (N = 152)
	%	%
Lens Correction	95.1	84.2
Visual Training	0.6	9.2
Lens Correction and Visual Training	4.3	5.3
Surgery	0.0	1.3
Total	100.0	100.0

95.1 per cent had lens corrections: 4.3 per cent, both lens correction and visual training: only 0.6 per cent received visual training. The treatments for the 152 referrals reveal that 84.2 per cent received lens corrections: 9.2 per cent, visual training: 5.3 per cent, both lens correction and visual training: 1.3 per cent, surgery.

When compared with the inquiries, the referrals present a smaller proportion of lens corrections and a larger proportion of visual training. This might be attributed to the effects of muscle balance tests used in the screening routine. On the other hand, the dominant factor in the identification of children under care was the wearing of a lens correction: others under care which did not include glasses, i. e., those receiving visual training or surgery only, may not have been identified and placed in the inquiry group. A sampling error of this nature might account, at least in part, for the larger proportion of lens corrections among inquiries and the larger proportion of visual training among referrals.

SUMMARY

1. The general outcomes of the Danbury Study are reviewed and the analysis of the data is extended.

2. Comparisons between children wearing glasses and children who do not possess glasses are made with reference to (a) failure rates on the screening test, (b) rate of change from fail to pass on retest, (c) parts of the screening test failed.

3. The doctor's reports are summarized with reference to (a) the need for reexaminations among children under care, (b) the need for

visual care among children referred for failure of the screening test. Referral ratings, diagnoses, and treatments are presented for children who failed different parts of the screening test.

4. The diagnoses and treatments for children under care when the study was initiated are compared with those for children referred for professional attention during the study.

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ANNOUNCEMENT

NORTHWEST CONGRESS OF OPTOMETRY TO MEET IN PORTLAND

The Northwest Congress of Optometry will be held December 9-11 in the Multnomah Hotel, Portland, Oregon. This is one of the large Optometric Extension Program meetings of the year and the educational sessions will stress the "Advanced Optometric Handling of Children."

The speakers will be Dr. Victor S. Glover, Roswell, New Mexico; Dr. Albert A. Sutton, Pueblo, Colorado, and Dr. A. M. Skeffington, St. Louis, director of the Graduate Clinic Foundation. Drs. Glover and Sutton have both completed work given by the Gesell Institute of Child Development.

Dr. Tole N. Greenstein, who is general chairman for this meeting, has also announced that there will be several special "workshop" sessions as part of the Congress.

STRAY LIGHT AND RETINAL INTERACTION*

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One of the ways in which a glare source in the periphery of the field of view can impair foveal vision is through stray light. The glare source projects a beam of light through the pupil of the eye and this beam forms an image of the glare source on the retina. It also gives rise to stray light part of which is scattered over the fovea of the eye. This stray light or veiling retinal illuminance impairs the visibility of objects imaged on this region of the retina.

At present one cannot determine the total amount of stray light falling on the fovea of the eye by evaluating individually the separate factors that contribute to it, such as flare, halation, scattering by the media, reflection from the coats of the eye, transmission through the sclera, and so on. One can, however, measure the effect of the glare source in the periphery of the field of view upon the visibility of an object at the center of the field by comparing it with the effect produced by a veiling patch of light superimposed upon the object. However, it has not been satisfactorily determined whether this effect is entirely due to stray light or whether retinal interaction is also involved.

Holladay[1, 2] and Stiles[3, 4] entertained the possibility that stray light and retinal interaction could both be involved. However, if retinal interaction is involved, it must, according to them, produce exactly the same effect as that mediated by stray light, and consequently it is not necessary in dealing with the practical aspects of such problems to think in terms of more than one factor.

LeGrand[5] on the other hand believed that retinal interaction makes a contribution which is quite different than the effect produced by stray light, and consequently believed it necessary to deal with the two factors separately.

Holladay and Stiles have shown that a small glare source at an angular distance θ (degrees) from the point of fixation produces an effect at the fovea which is equivalent to a veiling patch of light having a luminance B_v (candles per square foot) given by the following formula:

$$B_v = kE\,\theta^{-n} \qquad (1)$$

In this equation k and n are constants, and E (footcandles) represents

*Read before the annual meeting of the American Academy of Optometry, Chicago, Illinois, December 13, 1955. For publication in the November, 1956, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

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the illuminance in a plane through the center of the entrance pupil normal to the line of sight. Stiles investigated this effect for values of θ between one and ten degrees and found values of 4.16 and 1.5 for k and n respectively. Holladay investigated the effect for values of θ between 2.5° and 25° and found values of 9.2 and 2 for k and n.

Essentially the same effect has been found for glare sources in any meridian in the field of view.

Holladay used a bright ring as a test object, which was projected onto a white screen (Figure 1). With a given illuminance falling on

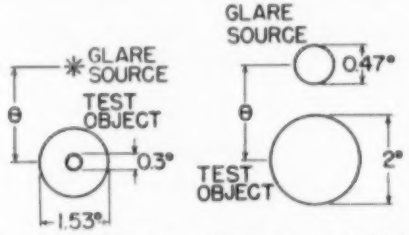

Fig. 1. (left) Stimulus pattern employed by Holladay.
Figure 2. (right) Stimulus pattern employed by Stiles.

the screen, and with the peripheral glare source turned on, he varied the luminance of the ring to make it just visible. The ring had a higher luminance at its core than at its borders. Then with the glare source turned off, he determined how much it was necessary to increase the general illuminance falling on the screen to bring the ring again to the threshold of visibility. This increase in the luminance of the screen is equivalent to superimposing a patch of veiling luminance B_v. Both eyes were used and no artificial pupils were employed.

Stiles used essentially the same arrangement and procedure except that both his test object and his glare source had the shape of a disk, as shown in Figure 2.

Both Stiles and Holladay investigated the effect of varying the intensity of the glare source to find out whether manipulating this variable is equivalent to changing to the luminance of a veiling patch of light. Both regarded as negligible the differences found in manipulating the separate variables. However, LeGrand has called attention to the small but significant and systematic decrease of the ratio B_v/E as the value of E increases, and he has used this fact as an argument that retinal interaction is involved in this situation.

It is possible that this effect is related to the fact that natural pupils were used by Holladay and Stiles in acquiring their data. The pupil is

smaller when the glare source is in the field than when the patch of veiling light is being used, and although the luminance of the test object is the same in the two cases the amount of veiling luminance required to reduce it to invisibility will be expected to be larger when the pupil is large than when the pupil is small, because the contrast threshold decreases as the level of retinal illumination increases. The result is that the value of B_v/E is larger when a natural pupil is used than when an artificial pupil is used. Furthermore, this difference increases as θ increases and E decreases.

LeGrand plotted values of B_v/E which he obtained from Holladay, Stiles and Pokrowski[4] on a single graph and fitted the three sets of data with a single curve. The curve which he used is shown in Fig. 3.

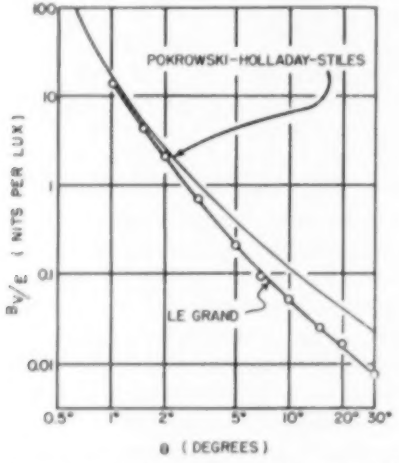

Fig. 3. Data of LeGrand compared with that of Pokrowski, Holladay and Stiles.

LeGrand has developed an ingenious method of measuring the effect of stray light at the fovea of an eye which does not incorporate the effects of retinal interaction. The eye is made to fixate a red point. A glare source at an angle θ from the fixation point is made to alternate with a patch of veiling luminance which covers the fixation point. The luminance B_v of this patch is varied till the brightness at the fixation point matches the brightness produced at the fixation point by the glare sources. This method involves successive comparisons of the two stimuli.

An artificial pupil was used to restrict the size of the beams enter-

ing the eye. This was kept normal to the line of sight through the center of the glare source. E has been used by LeGrand to designate the illuminance in the plane of the artificial pupil produced by the glare source. In the experiments performed by Holladay and by Stiles, the natural pupil can be assumed to be normal to the line of sight through the test object, and hence in order to compare LeGrand's data with those of Stiles and Holladay, it is necessary to multiply his B_v/E values by $\cos^2 \theta$. The corrected values are plotted in Figure 3 and can be compared with the curve which represents the combined data of Pokrowski.[6] Stiles and Holladay.

There is considerable discrepancy between the two curves.

LeGrand believed that his own method measured the effect of stray light alone, whereas, the method employed by the other investigators included retinal interaction. He proved that his own method provided a measure of stray light alone by showing that B_v/E is independent of the level of E even for large values of θ.

The fact that the two curves in Figure 3 show an increasing separation as θ increases, indicates, according to LeGrand, that the effect of retinal interaction increases. As explained above, this result may be due to LeGrand's use of an artificial pupil, and the failure of Holladay and Stiles to use one.

However, LeGrand used a second method in which he compared the effect produced by a glare source upon the apparent contrast between two parts of a test object with the effect produced by a patch of veiling light. He used an artificial pupil with the second method also, but found higher values of B_v/E, and concluded that this method incorporates an effect of retinal interaction.

The artificial pupil used by LeGrand was mounted at some distance in front of the cornea. A beam from the glare source and a separate beam from the test object must get through both the artificial pupil and the natural pupil of the eye. It is difficult to imagine how an observer copes with the problem of vignetting which must occur especially when the two beams have an angular separation of as much as 30°. LeGrand's method ought to be modified to avoid this difficulty.

In order to overcome the difficulties encountered with LeGrand's apparatus the following experiment has been designed. The apparatus is illustrated in Figure 4. The point 0 represents the center of the entrance pupil of one of the eyes. The other eye is occluded. The open eye fixates a point at the center of the aperture A_6 which is conjugate to aperture A_7 with respect to lens L_5. The aperture A_7 constitutes the test object which is imaged in the plane of aperture A_6. M_3

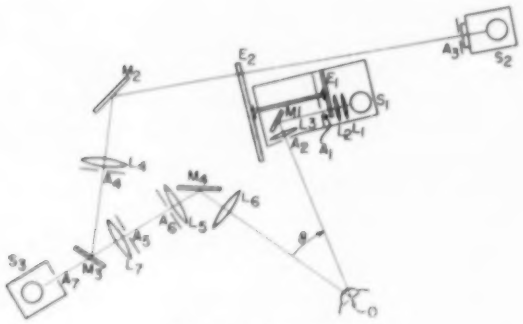

Fig. 4. Apparatus.

is a beam splitter which combines the light from source S_2 with the light from source S_3. The aperture at A_3 is imaged in the plane of the aperture at A_5 by lenses L_4 and L_7, and A_5 is imaged by lenses L_5 and L_6 in the plane of the entrance pupil. Light from A_3 completely fills the aperture at A_6. This disk shaped patch of light constitutes the patch of veiling brightness, which is superimposed upon the image of the target which is formed in the plane of the aperture A_6. Mirrors M_2 and M_4 are first surface mirrors.

The aperture at A_2 which is filled with light constitutes the glare stimulus. The mirror M_1 is a first surface mirror, and the lens L_3 forms an image of the aperture A_1 in the plane of the entrance pupil. The aperture A_1 is illuminated by an image of the ribbon filament at S_1 which is formed by the lenses L_1 and L_2. E_1 and E_2 are sectored disks which are synchronized so that the light source S_1 is cut off when the light from source S_2 is exposed. In this way the patch of veiling brightness can be alternated with the glare source. The unit consisting of E_1, E_2, A_2, L_3, M_1, A_1, L_2, L_1 and S_1 can be rotated around the center of the entrance pupil 0 to change the glare angle θ. In spite of the fact that this unit rotates around 0 the beam of light from A_3 to M_2 is always intercepted by the rotating sectored disk E_2.

Three stimulus patterns which may be used are illustrated in Figures 5, 6 and 7. Figure 5 represents the stimulus pattern for the flicker measurement of stray light. The two patches, b and b′, are parts of the aperture A_6 which are continuously illuminated by light from source S_3. When the rotating sectored disk E_2 is in position to transmit light from A_2, this light fills the whole field of aperture A_6.

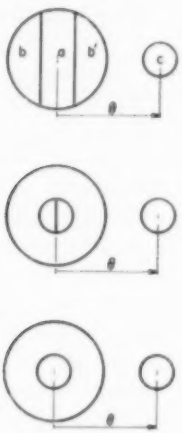

Fig. 5. (top) Stimulus pattern for the measurement of stray light by the flicker method.
Fig. 6. (center) Stimulus pattern for the study of the effect of stray light on perceived contrast.
Fig. 7. (bottom) Stimulus pattern for the study of the effect of stray light upon the contrast threshold.

including a, b and b′. It constitutes a patch of veiling brightness superimposed on b and b′. The rotating sectored disk E_1 exposes the light from S_1 which illuminates aperture A_1 which constitutes the glare source c at an angle θ from the primary line of sight. This produces stray light which covers the fovea. If the retinal illuminance produced by the stray light is equal to the veiling illuminance produced by source S_2 the strip a between b and b′ will cease flickering but as long as a difference exists in the retinal illuminances produced by S_2 and S_1 a flicker will be observed. The flicker in the segments b and b′ is masked by the continuous illumination of these areas by light from source S_2, so that the alternation of sources S_1 and S_2 cannot be detected in these two areas. The surrounding region of the retina is intermittently illuminated with stray light from c and the flicker is quite pronounced but the flicker in the periphery of the field of view does not interfere with the adjustment of the retinal illumination from source S_1 to match the retinal illumination from source S_2. The two segments b and b′ being seen continuously free from flicker make it an easy task for the observer to adjust S_1 to be equal to S_2 so that the flicker will disappear in the strip a.

This arrangement has been tried out and the subjects find it an easy psychophysical judgment to make.

In Figure 6 the bipartite field is produced by covering one-half of the circular aperture A_7 with a filter. This is imaged at the center of A_6. The target has a diameter of one degree at the eye. This arrangement permits the repetition of LeGrand's experiment described above in which he investigated the effect of a glare source upon apparent contrast. In repeating this experiment the subjects simply adjust the patch of veiling luminance until the contrast obtained in the presence of S_2 is the same as the contrast obtained in the presence of S_1.

In Figure 7 the small circular brightness threshold test object represents an illuminated aperture at A_7, imaged at the center of A_6. It subtends one degree at the eye. The aperture A_6 can then be illuminated with light from S_2 which gives a patch of veiling brightness superimposed upon the test object or one can introduce a glare source at A_2. This arrangement makes it possible to duplicate Stiles' experiment.

It should be noted that in repeating these various experiments with the apparatus described above, Maxwell viewing is provided for the test object, the glare source and the patch of veiling luminance. All three of these stimuli are viewed by means of beams of light which are confined to the central region of the pupil. As the glare source unit rotates around 0 the beam of light from the glare source continues to penetrate the center of the pupil. Since the beam passing through the pupil in each case is smaller than the natural pupil, variations in the natural pupil are made ineffective. The apparatus provided therefore an opportunity to investigate LeGrand's claim that the effect of a glare source is dependent in part upon retinal interaction.

It should be noted that the light between lens L_1 and lens L_2 is collimated and therefore interference filters may be placed between these two lenses to provide essentially monochromatic light for the purpose of testing the effect of wavelength upon the amount of stray light in the eye.

Although preliminary experiments have been made with the apparatus all that has been determined so far is that the experiments are feasible in the sense that subjects can make the judgments which are required of them. Preliminary experimenting has also lead to the discovery that the corneal reflex produced by the glare source is reimaged on the diaphragm at A_5 by lenses L_6 and L_7 and the light may be reflected back to the eye. In order to eliminate this source of trouble it was necessary to polarize the beam from S_1 and to place a piece of polaroid in the beam between L_6 and entrance pupil of the eye.

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ANNOUNCEMENTS

A NEW POST-GRADUATE COURSE AT INDIANA UNIVERSITY

Indiana optometrists and those optometrists in adjacent states near Indiana University Extension Centers can take advantage of a new course, *The Theory and Practice of Contact Lenses*, which is now available by the Indiana University Division of Optometry. The new course is a 20-hour non-credit course limited to eight optometrists per class and is available on request from the optometrists in any given area of the state.

The Indiana University operates educational centers at 10 points throughout the state. Hence, optometrists in any part of the state and in some adjacent states may attend these courses which are given once a week, with a minimum amount of travel involved. Two other courses are currently being offered by the Division of Optometry. These are *Case Analysis* and *Orthoptics*.

The instructor for the course in contact lenses will be Dr. Neal J. Bailey who has been teaching the course in contact lenses to the students in the Division of Optometry at Indiana University. All types of contact lenses will be covered, and opportunity will be provided for the students to make impressions of the eye, actually mold contact lenses, and have ample opportunity to fit the contact lenses to one another. The tuition for the contact lens course will be $45.00 and a certificate of attendance will be awarded on completion of the course.

DRAFTING THE REQUIREMENTS FOR A MINIMUM CLEARANCE CORNEAL CONTACT LENS*

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This paper is concerned with the problem of the corneal fit of minimum clearance contact lenses and a suggestion which, the writer believes, will improve the accuracy of the basic measurements of the radius, chord of the radius, and displacement of the corneal section of the lens.

Minimum clearance is defined as that overall corneal clearance which creates and maintains a capillary layer of lacrimal fluid between the contact lens and the cornea, yet does not allow the lens to touch the cornea.

If an eye mould casting is projected on a screen, using two of its meridians, that of least curvature and of greatest curvature, in a magnification of 10X, the resulting tracing or photograph made from this projection provides an excellent means for determining the radii and the chords necessary to clear the cornea with a minimum clearance. The projected image may be traced directly or caught on photo paper and developed.

The corneal-scleral junction points are marked on the tracing and a line drawn to connect them. From the center of this line, a vertical corneal perpendicular line is drawn. This corneal perpendicular line serves as a center from which the proposed inner corneal curve of the lens (the base curve) is drawn. The base curve should clear the corneal apex of the tracing by 1.2 to 1.5 mm. and joins the sclera at a point 1 cm. from the corneal-scleral junction. These measurements are 10 times greater than they will actually be in the finished lens, because the tracing is magnified 10X. The lens specifications are applied across the meridian of least curvature. The radii which satisfy these requirements will be very close to those of the proper corneal fit. The chord is measured from the two points where the base curve meets the sclera.

In those cases where the cornea is regular in curvature, and not overly large, one radius or base curve will suffice to properly clear the cornea with minimum clearance. In irregular cases, such as keratoconus, and in cases of large cornea, two or three base curves will be necessary. The base curves in cases of keratoconus will not be centered on the

*Submitted on April 8, 1956, for publication in the November, 1956, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
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corneal perpendicular line, especially the central curve. This is due to the fact that the corneal malcurvature is displaced downward and nasalward in most cases. It may also be necessary to displace the center of the base curves in order to properly clear the cornea. This displacement, computed on the enlarged diagram, is a measurable factor which is taken into consideration when constructing the lens, and should result in greater accuracy.

Diagramming of the proposed base curves to clear the irregular cornea, begin at the sclera and work inward to the apical curve. The use of templates made from circles of known radii drawn on transparent paper, are very helpful in designing the lens. The final adjustments will, of course, have to be made from observation of the lens in place on the patient's eye.

Fitting minimum clearance contact lenses by this method will need more study to improve precision and judge allowances, such as the distance between the projected corneal apex and the curve representing the proposed inner corneal haptic of the lens. In the future we will, perhaps, have the material from which to draw final conclusions. In any event, by this method, the visualization of the application is greatly aided.

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ANNOUNCEMENT

MANUAL OF PRE-SCHOOL VISION TESTS

Dr. William C. Ezell, Spartanburg, South Carolina, president of the American Optometric Foundation, has announced that the Foundation has supplied a grant-in-aid of $1,000 to Dr. Richard J. Apell of the Gesell Institute of Child Development to enable him to write a *"Manual of Pre-School Vision Tests."* When finished it is expected that this manual will be published by the American Optometric Association for distribution to its members.

Contributions to the Foundation should be sent to 208 Andrus Building, Spartanburg.

OCULAR MANIFESTATIONS ASSOCIATED WITH DIABETES MELLITUS—A CASE REPORT*

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Diabetes mellitus is a chronic disorder of metabolism, involving primarily the carbohydrates, secondarily the proteins and fats, and characterized clinically by hyperglycemia, glycosuria, polydipsia, polyuria, polyphagia, puritus, weakness, and loss of weight. The immediate cause of diabetes mellitus is a deficiency of endogenous insulin associated with heredity (a recessive characteristic), obesity, endocrine disturbances, infections and tumors (usually in the region of the gall bladder, pancreas, or duodenum), brain injuries (in the area of the mid-brain) and/or trauma.

It has been estimated that there are 2,500,000 persons in the United States who have diabetes and approximately one out of every four persons is a "diabetic carrier."

The fasting blood sugar as found in the normal individual is between 80 and 120 milligrams per 100 cc. of blood, whereas in the diabetic it may be 200 and higher.

The main concern of the optometrist and ophthalmologist is usually not with the general condition itself but with the ocular symptoms and manifestations which may occur.

The most frequently described involvements include retinopathy,[1] arteriosclerosis,[2] lens opacities,[3] iris changes[4], extra-ocular muscle paresis,[5] changes in the intra-ocular pressure,[6] amblyopia,[7] reduction in the amplitude of accommodation, unequal accommodation in the two eyes, and changes in the refractive state. In the case report to follow the main observed factors were changes in the amplitude of accommodation and the refractive state.

The accommodative mechanism becomes weakened and any attempt of the patient to perform close work may give rise to headaches, blurred vision, vertigo, and asthenopia. The onset is typically sudden but rarely is there a complete fatigue. Premature presbyopia is not uncommon in many of these patients. Frequently unequal accommodation will also be encountered. The mechanism involved in the reduction of the amplitude has, to this author's knowledge, not been discussed in the literature.

*Submitted on May 10, 1956, for publication in the November, 1956, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
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Marked changes in the refraction of the eye occur with sudden shifts in the blood sugar. A marked drop in the blood sugar causing hypoglycemia gives rise to a sudden decrease in the amount of myopia or an increase in the amount of hypermetropia present.[8] The hypermetropic condition seems to follow a sudden myopic change and usually does not occur as an initial variation. Even diabetic patients who are fairly well stabilized suffer a more frequent fluctuation in their refractive condition than non-diabetic patients of the same age.[9]

According to Duke-Elder[10] there are three main theories to account for the change in refractive error with a rise of sugar concentration in the blood stream.

1. Hydration of the cortical layers of the lens relative to the nucleus. (Duke-Elder)
2. Hydration of the nucleus of the lens was responsible for the hyperopic changes. (Grandstrom)
3. Increased refractive index of the lens due to changes of a precataractous nature caused by toxic agents. (Grandstrom, Bucklers, Weekers)

We may assume that these theories are valid insofar as postulating lenticular changes since in aphakic patients diabetic refractive changes do not occur with a change in the blood sugar concentration.

CASE REPORT

The patient under study has had diabetes for thirteen years. At the age of twelve the disease became apparent. The usual symptoms of thirst, loss of weight, excessive urination, and dehydration were present at the onset. The assumption was made that the etiological factor was hereditary since an uncle and grandmother (both now deceased) presumably had the same condition. Twenty-five per cent of diabetic patients have a familial history. At this time the disease has not appeared in any other member of this family.

At the first examination in the fall of 1947 (#1 - Table I) the patient complained of blurred distant vision. Diabetes of five years' duration was disclosed in the history and daily injections of Globulin insulin were being administered. Ophthalmoscopy: Media clear with no retinal changes.

The next examination two years later in the fall of 1949 (#2 - Table I): Symptoms and complaints of blurred far vision even with prescription lenses. He was receiving injections of protamine zink insulin. Ophthalmoscopy: negative.

A few months later (#3 - Table I) the patient complained of far and near blurred vision and of frontal headaches which occurred several

times a week in the late afternoon. He was then using protamine zink and regular insulin daily. Ophthalmoscopy was again negative with no retinal changes. The patient wore his prescription (#3 - Table I) for several weeks and then complained of a "pulling sensation" in his right eye. At this time a fourth refractive study was performed (#4 - Table I).

At the age of 24 (fall, 1953) the patient complained again of blurred distant vision and he could not read comfortably through the present lenses. He also tired very easily. His visual acuity with no lenses was: O.D. 20/80; O.S. 20/50; O.U. 20/40. Ophthalmoscopy: negative, media clear and fundus normal. Ductions were adequate. The static retinoscopy indicated, O.D. —1.75 sphere. O.S. —1.50 + 0.25 x 100. After the refraction (#5 - Table I) the patient was

TABLE I

Date	Age	Blood Sugar mgs. per 100 cc. blood	Refractive State O.D. Sphere Only	O.S. Sphere Only	Max. V.A. O.U.	Amp. of Accom.	Add O.D.	Add O.S.
#1 Fall 1947	18	179	—0.25	—0.25	20/15			
#2 Fall 1949	20	186	—0.25	—0.50	20/15			
#3 Winter 1949	20	284	—1.25	—0.50	20/20		+1.75	+1.00
#4 Two weeks later	20		—1.00	—0.25	20/20		+1.75	+1.00
#5 Fall 1953	24	330+	—1.50	—1.00	20/15	3.50	+1.50	+1.00
#6 4½ hours later	24	200	—0.75	—0.50	20/15	4.25		
#7 Next day	24	180	—0.25	—0.25	20/15	5.00		
#8 October 1954	25	120	plano	plano	20/20	6.00		
#9 Next day	25	246	—0.75	—0.75		3.75	+1.25	+1.25
#10 Third day	25	319	—0.75	—0.75			+1.25	+1.25

advised to remove his glasses for near work. A second refraction was made four and one-half hours later on the same day (#6 - Table I). The visual acuity with no prescription on was: O.D. 20/80; O.S. 20/50; O.U. 20/40. The static retinoscopy revealed: O.D. —0.50 + 0.25 x 90. O.S. —0.50 + 0.25 x 100.

The third examination made the following morning (#7 - Table I) showed the following findings: Visual acuity with no prescription was: O.D. 20/60; O.S. 20/30; O.U. 20/30. The ductions were again adequate and the fundus was normal. The static retinoscopy showed: O.D. —1.00 +0.25 x 90. O.S. —0.75 + 0.25 x 90.

Comparing these findings we can realize the rapidity with which the blood sugar, refractive state, and the amplitude of accommodation may fluctuate.

Until 1954 the patient had uncontrolled diabetes for thirteen years with no signs of ocular pathology or fundus changes. He was now a student in a graduate college.

In October of 1954 insulin was purposely neglected for a period of four days. On the first day the patient had no symptoms or complaints. On the second day no prescription was needed at the beginning of lectures at 8:00 A.M. During a 9:00 A.M. lecture the patient noticed that things began to get increasingly blurred. Far and near work became uncomfortable until he used prescription lenses (#9 - Table I). The patient was very irritable, tense, and nervous and his skin was dehydrated. On the third day the patient needed prescription lenses (#10 - Table I) for all critical seeing. The patient was increasingly irritable, tense, and nervous. He had lapses of memory at times, and did not remember what he was told or what was said during lectures and in casual conversations. He was very thirsty, tired, weak, and at times had diplopia. His skin was dehydrated. On the fourth day distant objects were blurred even with prescription lenses. Diplopia was more frequent than at the preceding day. His skin was dehydrated and flaky. The patient was extremely thirsty in spite of the fact that he would drink a quart of liquid at a time. He urinated hourly and was drowsy, tired and very weak (getting up from a chair was an effort), and his memory was exceedingly poor for most of the day.

In December of the same year the patient, while under observation, administered an overdose of N.P.H. insulin for experimental purposes. Lectures were attended as usual. In the morning he needed prescription lenses for distant seeing only (—0.75 D. spheres O.U.). Later he did not need his prescription but noted a beginning frontal headache. In the late afternoon during a lecture he had a typical insulin reaction.

He broke into a cold sweat and became very nervous, tense, and felt "keyed up and rareing to go," his coordination was poor and he also had a lapse of memory for certain parts of the day.

In addition to the preceding findings the patient was observed during an aniseikonic refraction. Although the results showed aniseikonia to be present they did not indicate it was associated with the rising or falling of the blood sugar level.

SUMMARY AND CONCLUSIONS

1. An increase in the refractive state and a decrease in the amplitude of accommodation is found to be associated with an increase in the blood sugar level.

2. These changes may take place in a relatively brief period of time.

3. The fact that these changes may occur rapidly would tend to support Duke-Elder's view that these changes are the result of hydration of the cortical layers of the lens.

4. This patient also has demonstrated a possible paresis of the lateral rectus muscle, indicating that with the increase of the blood sugar the muscle function is also affected.

5. In addition to the variations in the amplitude of accommodation, unequal amplitudes were indicated by the variation in adds prescribed. Subjectively, accommodation was reported to be difficult and associated with rapid fatigue.

6. During the period covered by this study, the fundus picture remained normal. No lens or iris changes were observed.

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NEW RESOURCES IN OPHTHALMIC LENSES*

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In recent years chemists have developed, as an alternative to glass, a hard transparent resin, chemically identified as polyallyl diglycol carbonate[1]. This new lens substance possesses the lightness and great strength of the best previous optical plastics. At the same time it is superior to them in resistance to heat, to chemicals and especially to abrasion.

The newer material is initially a clear liquid. When this is combined with an appropriate catalyst and heated in an oxygen-free atmosphere it slowly hardens into a highly transparent, colorless solid. The result is a strong, hard, insoluble, infusible optical medium of light weight and great impact resistance.

The molecular structure of this allyl resin resembles the three-dimensional, cross-linked network of another organic high polymer, diamond. As a consequence of the molecular cross-linkages, the newer material possesses a general durability not existent in the common, linear-linked soft plastics. It is 10 times more resistant to flying abrasives than methyl methacrylate, the hardest of the earlier transparent plastics. It is 20 to 30 times more resistant than methacrylate to ordinary rubbing or scouring abrasion. (Figure 1-a.) It withstands boiling without harm. It surpasses even methacrylate in impact strength, exhibiting in certain tests twice the break resistance. (Figure 2.)

COMPARISON WITH GLASS

This hard resin is more transparent than crown glass. It is made from refined and filtered liquids, instead of from the mined solids used in glass making. Consequently, it is freer from minute inclusions and exhibits less internal haze and scatter than glass. It is more resistant than glass to attack by practically all chemicals.[2] Acetone, paint-remover, even hydrofluoric acid do not harm it. In drop-ball impact resistance the material is superior to the best case-hardened glass available.[2]. Under high velocity impacts, when steel pellets are shot against it, the resin withstands impacts four times greater than those which shatter the best case-hardened safey glasses.

Hot grinding wheel sparks do not burn or adhere to this resin.[3]

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*Read before the annual meeting of the American Academy of Optometry, Chicago Illinois, December 13, 1955. For publication in the November, 1956, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

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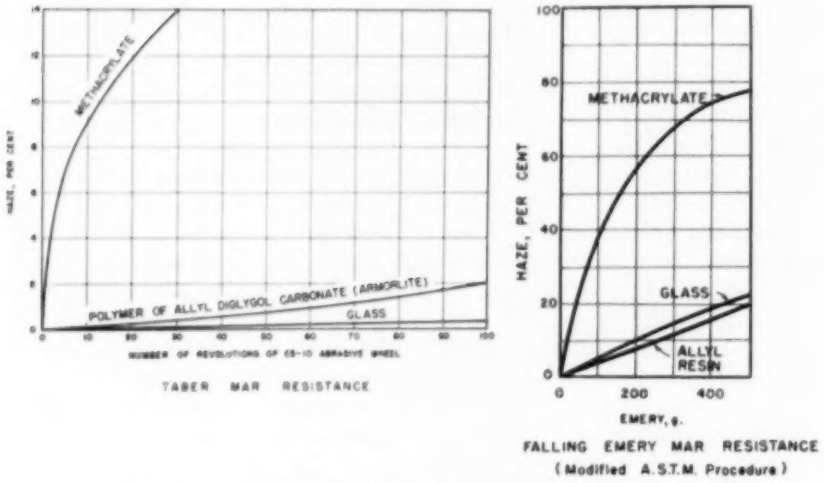

Fig. 1-a. Susceptibility to abrasion of common plastic compared with that of Armorlite and glass, at left and at right.
Fig. 1-b. Susceptibility to flying abrasives of regular plastic, hard resin and glass.

Neither does welding spatter, whereas glass, being both brittle and thermo-plastic, shows poorer resistance to both.[3]. (See Figure 3.)

As Figure 1-a shows, the allyl resin approaches, but does not equal glass in scratch-resistance when abrasives are rubbed or scoured across the surfaces. However, when subjected to flying abrasives, the resin is more scratch resistant than glass (see Figure 1-b). This property is due to the higher elasticity of the resin and to its more complete recovery after indentation.[4] It results in superior resistance to sandblast, to dust storms and to particles thrown from grinding wheels. Since the resin

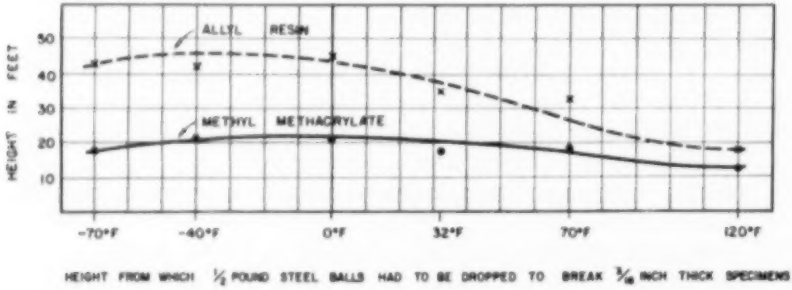

Fig. 2. Comparative impact resistance of allyl resin and methyl methacrylate.

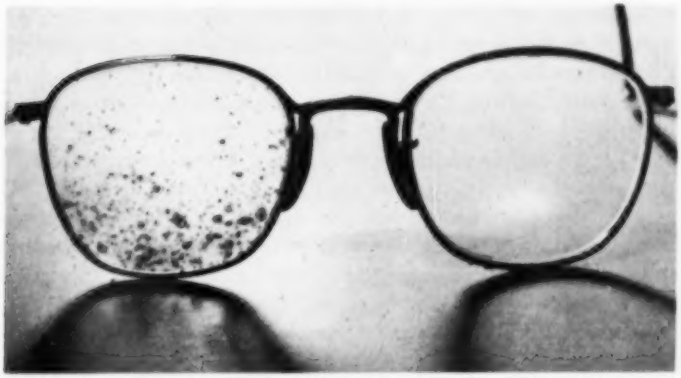

Fig. 3. A glass lens (left) and a hard resin lens (right) after equal exposure to welding spatter.

has a lower thermal conductivity than glass, it is much more resistant to condensation of moisture onto the surfaces during abrupt temperature changes.[3, 5]

Lenses made of pure allyl resin are now available in most single vision and bifocal powers. Two of the properties of these lenses merit special discussion because they are particularly important in ophthalmic lenses: (a) Glasses, when broken on the face, can create a serious hazard to the very eyes they were intended to help. In contradistinction to this, hard resin lenses provide great eye protection. Their high protective coefficient results from two special characteristics: One is the great impact resistance of the material, previously mentioned. This property alone makes them the safest lenses ever created. In addition to this, fragmentation, when it does occur, usually yields large and obtuse segments instead of the small sharp spicules found in broken glass. Unlike glass, the edges of fractures are comparatively dull and do not easily lacerate human tissues. (b) The exceptional clarity of the lenses is due to two factors: One is their superior transparency and freedom from internal haze, already mentioned. The other is their high resistance to condensation of moisture onto the surfaces during abrupt temperature changes. This keeps them relatively free of the fogging which frequently obscures glasses when going indoors in winter-time, or when emerging from refrigerated areas at any time of year.

A paper was read at the 1948 annual convention of the Academy describing the first hard resin lenses.[6] Since their introduction, they have come into use by thousands in every state and province of North America.

The AMERICAN JOURNAL OF OPHTHALMOLOGY describes them as the most important new optical medium since the invention of glass.[7] The American Medical Association's ARCHIVES OF OPHTHALMOLOGY has published data showing that hard resin produces the safest of all lenses to wear.[8]

Sir W. Stewart Duke-Elder, in the most recent volume of his *Text Book of Ophthalmology*, states: "The limitations of earlier plastic lenses have been largely overcome by the use of a hard thermosetting resin, Armorlite, which compares well with glass in resistance to scratching and is superior to it in resisting pitting, as when used at a grinding wheel or when welding or sandblasting."[9]

Lenses which earn authoritative appraisals such as these represent a significant new resource in the correction of vision. This new type of lens is indicated today whenever the economics of the case do not forbid.

The two limitations of hard resin lenses are their moderately higher initial cost to the patient, and their need for occasional replacement due to scratching. These are both economic matters. Except for these cost factors, almost everyone would prefer to wear resin lenses because of the increased lightness and comfort, the greater freedom from misting and the peace of mind which goes with eye safety. Additional cost, when accompanied by additional advantages, is often met willingly, particularly in times like the present, when millions share in the greatest general prosperity the world has ever seen. If, today, optometrists could not offer technological improvements in the lenses they use, they might well come to be regarded as falling behind in a time when great technological progress is going on all about them.

For certain types of patients, the advantages of the new lenses have very special value. Among these are: (1) Patients with prescriptions that would be heavy in glass. (2) Individuals who have lost most of the sight in one eye, due to disease, damage or amblyopia. They, most of all, need protection of remaining good eye. (3) Policemen, firemen and athletes, to eliminate the danger of glass splinters in any rough and tumble situations. (4) Industrial workers—particularly if they object to the thickness and weight of case-hardened lenses or goggles, or if welding spatter is a problem. (5) Those who break their glasses frequently. (6) All who engage in sports such as golf, horseback riding, baseball, etc., where ordinary glasses would be dangerous if struck or splintered. (7) Children—the eyes of children are particularly precious. Yet glass is particularly hazardous on the eyes of active, playful youngsters.

Suggestions for maximum success in the use of hard resin lenses.

The first principle in the management of hard resin lenses is: *Never withhold from a patient the opportunity to have safer, more comfortable lenses.* Let the patients know that there is a modern alternative to glass, for often it will be preferred. Frequently, patients will choose glass lenses for sedentary uses and tinted resin lenses for outdoor activities, including driving a car.

With resin lenses, the length of service depends not on unpredictable accidents, but directly on the care they receive. Hard resin lenses which receive proper care usually serve until it is time for the next eye examination. Hence the second management principle is: *Always caution patients that wear depends on care.* Proper care consists principally of washing or blowing grit and dust from the surfaces before wiping them with a clean cloth.

Resin lenses of industrial safety thickness are the most breakproof thing in optics. They can be bounced off the floor like a ball. However, nothing is utterly unbreakable and hard resin, when thinned to regular spectacle lens proportions, will lose some of its strength. This is particularly true if it is also weakened by drilling. Drilled resin lenses are stronger than glasses of equal thickness—but they can crack through the drill holes. Drilling is unthinkable in other types of protective lenses and it weakens even resin lenses. Therefore, the third principle is: *Where maximum eye-protection is called for, do not drill a lens.* Fortunately, it is not necessary to sacrifice strength by drilling. If a rimless mounting is desired, resin lenses should be put into a Balgrip or other type of mounting which eliminates drilling. In this way, even the wearers of rimless mountings can be provided with genuine eye-protection.

With the weight problem solved, the current tendency is toward larger eye-sizes and extreme shapes. When the lens power is moderate, this takes advantage of the lightness of the new lenses. *However, when a prescription is strong, resist the tendency to large eye sizes and extreme shapes.* The stronger the lens power the more conservative should be the size and shape so as to keep lens thickness to a minimum.

SUMMARY

Science has produced lenses which convert spectacles from an eye-hazard into a source of great protection to the eyes. At the same time the comfort in wear has been increased by eliminating half the usual weight. So much lightness and clarity, durability and eye-safety have not previously been combined in lenses. Certain suggestions have been made for maximum success in their use.

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A NOTE ON CONTACT LENS STAINING BY STRIP FLUORESCEIN*

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For many years it has been customary and satisfactory to stain with liquid fluorescein to ascertain proper contact lens fit and positioning. One problem has been the chemical alteration of that agent since it may and often does become toxic after being opened a short time. Various types of buffers have been used to prevent such an action with moderate success.

The relatively recent introduction of the fluorescein sodium agent in the form of a strip, 3 by ½ cm., in crystal form has made the stain static in composition permitting an indefinite supply on hand at all times, and without the necessity of using buffers or other cautions. Optometrists and patients in general prefer this simpler, more expedient approach in the staining in corneal lens work. Commercially, the strip contains 9.3 milligrams of fluorescein sodium, two strips to an envelope, and is available as samples from the Ophthalmos, Inc., of Union City, New Jersey, upon request.

The strip, known as Fluor-I-Strip, is placed in the lacrimal sac with the lids lightly closed for one minute at which time complete absorption takes place. The author has used this procedure with a number of patients and can recommend it with confidence.

*Submitted on August 9, 1956, for publication in the November, 1956, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

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THE INFLUENCE OF PROLONGED STAY IN THE DARK ON FOVEAL DARK ADAPTABILITY*

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Pensacola, Florida

It is well known that dark adaptation proceeds in two stages. In the first, it is very rapid, short in duration and adaptability is low; and in the second, it is slow, prolonged and adaptability is high. The first stage is concerned with cone function (cone or foveal dark adaptation); in the second with rod function (rod or peripheral dark adaptation). It is generally accepted that the cone or foveal dark adaptation is rapid and is completed in a few minutes.[2, 3] The following work was undertaken in an attempt to determine the effect of prolonged exposure in the dark on cone dark adaptation.

METHODS

The measurement of the foveal dark adaptability was carried out with the use of a Nagel's adaptometer.[4] The test field was a circular one and subtended a visual angle of 1 degree. A red filter (765 $m\mu$) was placed over the test field. A small "star" of red light was used as a fixation point and placed just within the upper margin of the test field. The subjects' eyes were first exposed to a white light of 200 Lux for preliminary light adaptation for five minutes. Then the subject was exposed in the dark and tested for his foveal dark adaptability by rotating the adjusting wheel of the adaptometer at desired time intervals for the just imperceptible intensity of the test field. Based upon the Nagel's table[4], the relative stimulation intensity or relative sensitivity value was obtained. For the sake of convenience, all values of the relative stimulation intensity are given as logarithm values. The light source for the light preadaptation apparatus and the adaptometer was supplied by a constant 100 V. battery. Time was measured with a stop watch.

RESULTS

Two healthy subjects (F. and H.) were selected for test. They were instructed in the use and handling of the Nagel's adaptometer.

*Submitted on August 15, 1956, for publication in the November, 1956 issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
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Naval Project NM 001 059.30.01. Opinions or conclusions contained in this report are those of the authors. They are not to be considered as necessarily reflecting the views or endorsement of the Navy Department.

Table 1. Average and Range of Five Measurements of Cone Dark Adaptation During the Prolonged Stay in the Dark for Subjects F. and H.

Time in Dark (hr.)		Log. relative stimulation intensity				Relative sensitivity value			
		Subject F.		Subject H.		Subject F.		Subject H.	
		Average	Range	Average	Range	Average	Range	Average	Range
1/120	(½′)	7.76	7.75-7.78	7.78	7.76-7.79	1.7	1.7-1.8	1.7	1.6-1.7
1/60	(1′)	7.49	7.49-7.53	7.23	7.19-7.27	3.3	3.0-3.4	5.9	5.6-6.4
1/30	(2′)	7.29	7.25-7.32	7.01	7.00-7.02	5.1	4.8-5.7	9.8	9.6-10.0
1/20	(3′)	7.06	7.03-7.09	7.00	6.96-7.02	8.7	8.3-9.3	10.0	9.6-10.9
1/12	(5′)	7.06	7.05-7.08	7.01	6.98-7.03	8.7	8.3-8.9	9.8	9.3-10.4
1/4	(15′)	7.09	7.08-7.11	7.00	6.98-7.02	8.1	7.8-8.3	10.1	9.6-10.4
1/2	(30′)	7.07	7.04-7.11	7.01	7.00-7.02	8.5	7.8-9.1	9.8	9.6-10.1
1	(60′)	7.08	7.06-7.11	7.01	6.98-7.03	8.3	7.8-8.6	9.8	9.3-10.4
1½	(90′)	7.06	7.00-7.08	6.95	6.86-7.01	8.7	8.3-9.1	11.1	9.8-13.9
2		7.02	6.98-7.04	6.90	6.83-6.95	9.5	9.1-10.4	12.7	11.2-14.7
3		6.96	6.93-6.99	6.82	6.75-6.86	10.8	10.3-11.6	14.7	13.9-17.9
4		6.91	6.88-6.94	6.72	6.60-6.75	12.3	11.4-13.2	19.1	17.9-25.0
5		6.85	6.82-6.88	6.66	6.60-6.72	14.1	13.2-14.7	21.7	19.2-25.0
6		6.81	6.78-6.88	6.64	6.58-6.70	15.6	13.2-16.7	22.7	20.0-26.2
7		6.78	6.72-6.82	6.64	6.60-6.66	16.7	14.7-19.2	23.1	21.7-25.0
8		6.74	6.72-6.76	6.63	6.60-6.66	18.2	17.1-19.2	23.6	21.7-25.0
9		6.69	6.63-6.73	6.64	6.62-6.66	20.2	18.5-23.5	22.8	21.7-23.8
10		6.69	6.67-6.74	6.64	6.62-6.64	20.3	17.9-21.4	23.1	22.7-23.9

The foveal dark adaptation was then detected at given time intervals in the dark. The results thus obtained are shown in Table 1. This indicates that within the first one or two minutes of dark adaptation the threshold of the relative stimulation intensity dropped very rapidly and later from 2 or 3 to 90 minutes the foveal dark adaptability became rather constant. After three hours' stay in the dark the dark adaptation of the cone portion showed slight improvement with little lowering of threshold. With the test continued, a further improvement was observed. This can be seen more clearly from the relative sensitivity value of cone portion than from the relative stimulation intensity when plotted as in Figure 1. It is found that the speed of such an improvement varied with individuals. In the case of subject H., for instance, twice as high a relative sensitivity value was obtained after five hours as after one, and in subject F., there was a slightly slower increase in value until seven hours later when the sensitivity of the cone portion was two times as high as after one hour. The maximal improvement in cone adaptation for both cases, however, remained as late as 8 to 10 hours in the dark.

DISCUSSION

The mechanism of this phenomenon is hard to explain as the nature of the photochemical process of the foveal dark adaptation is still not clearly known. Hecht[2, 3] has shown that the process of the foveal

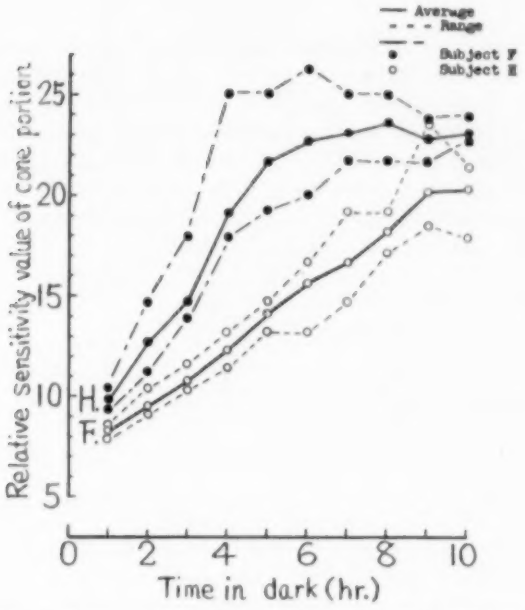

Fig. 1. Average and range of 5 measurements of cone dark adaptation during the prolonged stay in the dark for subjects F. and H.

function is very rapid—being practically over in a few minutes. In this experiment, it is also apparent that staying in the dark for from 2 to 3 to 90 minutes the foveal dark adaptation showed no significant change. This would indicate that by that time the regeneration of cone substance has already been completed. Moreover, Piper[5] and Achmator[1] reported that in a much more prolonged adaptation up to 8 or 24 hours a gradual improvement in rod or peripheral dark adaptation was noticed. This, too, cannot be accounted for as a rod function, as the regeneration of the visual purple does not require this great length of time. Therefore, it is reasonable to suggest that the further increase of the foveal dark adaptability may be complicated by some nervous and/or cortical factors (the nervous tissue of the visual mechanism and/or the cerebral cortex) induced by prolonged stay in the dark. It has been shown that the absolute sensitivities of rods and cones are approximately equal in the extreme red end of the spectrum.[6, 7] This introduces the possibility that the results here reported do not represent cone activity alone.

SUMMARY

From results so far obtained it is evident that the improvement in cone or foveal dark adaptation within two or three minutes was very rapid. After three to four hours' stay in the dark the sensitivity of the cone portion showed a gradual increase. On a much more prolonged adaptation, up to 5-7 hours, the foveal dark adaptability became two times as high as after one hour. The maximal degree of the adaptability was shown at the eighth to tenth hour in the dark. The possible mechanism of such phenomenon is discussed.

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BOOK REVIEW

COMPARATIVE ANATOMY OF THE EYE. Jack H. Prince, F.B.O.A., F.S.M.C., F.R.M.S., F.Z.S. (London). Published by Charles C. Thomas, Springfield, Illinois. 418 pages. Illustrated. Cloth, $8.50. 1956.

The author of this text is an assistant research professor, Department of Ophthalmology, University Hospitals, The Ohio State University, Columbus, Ohio. He has specialized in comparative anatomy, first in England, later in Australia and more recently in America. The book is a text to be used in teaching undergraduate and graduate students of anatomy. It is most clearly and simply written and is very well illustrated. In fact, the author was very well known for his illustrations in this field while still in England. Considerable new material appears in this new book due to the author's studies of this subject while in Australia. The author is an optometrist as well as a specialist in comparative anatomy. He is a member of the American Academy of Optometry. This is a useful addition to any group of optometric reference works.

CAREL C. KOCH

AMERICAN JOURNAL OF OPTOMETRY
and ARCHIVES *of*
AMERICAN ACADEMY OF OPTOMETRY
Established 1924

Vol. 33 November, 1956 No. 11

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Publication and Academy Office: 1508 Foshay Tower, 821 Marquette Ave.
Minneapolis 2, Minnesota

Annual Subscription, United States and Canada, $7.00 in Advance; Foreign, $7.50;
Single Copies 70c

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Published Monthly by the
AMERICAN JOURNAL OF OPTOMETRY PUBLISHING ASSOCIATION

The American Academy of Optometry and the publishers of this journal have no objection to the reprinting by other magazines of any of the articles in this issue, provided such reprints are properly credited to the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

ATTRACTING FUTURE OPTOMETRISTS

There are a number of ways of attracting future optometrists to enroll in our undergraduate educational centers. Each produces some good results when applied properly and all generally accepted plans should be pushed with vigor. Among these, however, is one which is at times overlooked by optometrists. It is probably the best long range plan of all, as it not only enrolls future optometrists, but also enhances the standing of the optometrist who applies the plan in a day-in and day-out manner.

The plan itself is simple. We all have young, exceptional students as patients. As these students move up through the Grades, we see them each year, and in time the relationships between the student and optometrist becomes quite friendly, and naturally various topics are discussed with the patient during each visit to the office. When those selected students have reached the 8th Grade, the optometrist may properly discuss the future of the patient, and the advisability of taking college preparatory work while in high school. At this time the patient is

naturally undecided as to his future plans, but it does no harm to him to talk of the advantage of future college training.

This is done routinely with all selected students, and the subject is touched on again and again from time to time during the high school years. By the time each selected student has finished the 12th Grade, the subject of specific courses may be brought up along with the need for taking qualifying examinations. Sometime during this period, the thought of becoming an optometrist may be mentioned. Obviously, no pressure should be applied, but the patient and his parents naturally feel some satisfaction in being in the hands of a professional man who so enjoys his work as to recommend it to others. As the doctor-patient relationship in these cases is already strong, the idea may take root.

With a carefully selected group of young patients, this program can and will result in a slow but sure flow of undergraduate students into our college and university courses. Naturally, not all young patients are approached, but many of the more promising ones may be, and in doing so the pride in one's work will also be enhanced, and the attitude of many families towards optometry itself will be improved. In addition, as this plan becomes more widely adopted, a selected group of fine young people will come into optometry to take our places in the years to come.

This is a long range program, but if followed sincerely and properly, by thousands of optometrists now in practice, it will result in an outstanding flow of new optometrists who will be assets to the profession.

CAREL C. KOCH

DATES SET FOR A.O.A. CONGRESS AND OPTICAL FAIR

Dr. D. LeRoy Leatart, Long Beach, A.O.A. Convention Committee Chairman, has announced the dates of June 23-26, 1957, for the coming Annual Meeting of the American Optometric Association in the Statler Hotel at Los Angeles.

Mr. Charles F. Oddy, New York City, Secretary-Treasurer of the Optical Manufacturers Association, has announced the dates of June 7-10, 1957, for the coming Optical Fair in the Palmer House at Chicago.

TRANSACTIONS OF THE
AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

PROGRAM OF THE AMERICAN ACADEMY OF OPTOMETRY

Shamrock-Hilton Hotel, Houston, Texas
December 8, 9, 10 and 11, 1956

Saturday, December 8, 1956

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8:30 Registration.

10:00 Business Meeting.
President's Annual Report
John D. Perry, Jr., O.D.
Secretary's Annual Report
Carel C. Koch, O.D.
Announcements by Chairman of the Papers and Program Committee.
J. Donald Kratz, O.D., A.B.
Announcements by Chair-of the Sections:
O. L. McCulloch, O.D.
Section on Aniseikonia.
Bernard Mazow, O.D.
Contact Lens & Sub-Normal Vision Section.
Herman Sager, O.D.
Section on Occupational Optometry.
Paul Connolly, O.D.
Section on Orthoptics.
M. J. Hirsch, O.D., Ph.D.
Section on Pathology.

11:00 Chalkboard Color Preferences Among Teachers.
Captain Albert P. Alder, U.S.A.F.
H. W. Hofstetter, O.D., Ph.D.
Division of Optometry, Indiana University, Bloomington, Indiana.

11:20 Discussion.

11:30 The Relationship of Close Work to Refractive Error in a Selected Junior High School Sample.
Melvin Nadell, O.D., Ph.D., Los Angeles College of Optometry, Los Angeles, California.

12:00 Discussion.

12:10 Luncheon Recess.

1:30 The Effect of Age on Visibility.
Sylvester K. Guth, B.S., D.O.S., Radiant Energy Effects Laboratory, General Electric Company, Nela Park, Cleveland, Ohio.

2:00 Discussion.

2:10 The Resting State of Accommodation.
Meredith W. Morgan, Jr., O.D., Ph.D. School of Optometry, University of California, Berkeley, California.

2:40 Discussion.

2:50 Field of View of Visual Aids.
Gerald Westheimer, O.D., Ph.D. School of Optometry, The Ohio State University, Columbus, Ohio.

3:10 Discussion.

3:20 Lenticonus—A Photographic Slit Lamp Study of the Anterior Surface of the Lens.
Merrill J. Allen, O.D., Ph.D., Division of Optometry, Indiana University, Bloomington, Indiana.

3:50 Discussion.

4:00 The Stiles-Crawford Effect—A Theoretical Treatment.
Jay M. Enoch, O.D., Ph.D., School of Optometry, The Ohio State University, Columbus, Ohio.

4:20 Discussion.

4:30 Projection in Anomalous Correspondence.
Neal J. Bailey, O.D., Ph.D., Division of Optom-

etry, Indiana University, Bloomington, Indiana.

4:50 Discussion.

5:00 A Basic Clinical Unit Applicable to Myopic and Non-Myopic Individuals.
C. B. Pratt, O.D., College of Optometry, Pacific University, Forest Grove, Oregon.

5:15 Discussion.

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Sunday, December 9, 1956

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9:00 Section Meetings.

11:10 Visual Factors in Automotive Design and Engineering.
Paul L. Connolly, O.D., Royal Oak, Michigan.

11:50 Discussion.

12:00 Pupil Size and Measurements of Veiling Luminance.
Glenn A. Fry, O.D., Ph.D., School of Optometry, The Ohio State University, Columbus, Ohio.

12:20 Discussion.

12:30 Luncheon Recess.

2:00 Sub-Normal Vision Symposium.
Moderator—Bernard Mazow, O.D., Houston, Texas
Description of Sub-Normal Visual Aids. William W. Policoff, O.D., Wilkes-Barre, Pa.
Conditions Resulting in Sub-Normal Vision. Bernard Mazow, O.D., Houston, Texas.
Optics of Sub-Normal Vision Devices. V. J. Ellerbrock, O.D., Ph.D., School of Optometry, The Ohio State University, Columbus, Ohio.
Clinical Procedures in Fitting the Sub-Normal Vision Patient. John C. Neill, O.D., Pennsylvania State College of Optometry, Philadelphia, Pa.
Rehabilitation of the Sub-Normal Vision Patient. William Feinbloom, D.O.S., Ph.D., New York, New York.
Illumination for the Visually Handicapped. Sylvester K. Guth, B.S., D.O.S., Radiant Energy Effects Laboratory, General Electric Company, Nela Park, Cleveland, Ohio.

5:30 Discussion.

5:45 Dinner Recess.

7:30 Motion Picture Photography of Some Interesting Eye Movements During the Cover Test.
Merton C. Flom, O.D., M. Opt. School of Optometry, University of California, Berkeley, California.

8:00 Discussion.

8:10 Practical Application of the Optometric Budget Plan.
H. B. Hewett, O.D., Lake Charles, Louisiana.

8:30 Discussion.

8:40 Visual Problems of Flight.
Lt. Robert S. Arner, U.S.A.F., Loring A.F.B., Maine.

9:00 Discussion.

9:10 The Aberrations of Ophthalmic Lenses.
Edwin W. Bechtold, O.D., Ph.D., Middle Village, New York.

9:30 Discussion.

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Monday, December 10, 1956

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9:00 Section Meetings.

11:10 Diagnosis and Prognosis in Amblyopia.
Ralph W. LeDrew, O.D., Edmonton, Alberta, Canada.

11:40 Discussion.

11:50 Relationships of Reading Types to Uncorrectible Low Visual Acuity.
Jack H. Prince, F.B.O.A., F.S.M.C., F.R.M.S. (Eng.), Department of Ophthalmology, University Hos-

pital, The Ohio State University, Columbus, Ohio.

12:20 D'scussion.

12:30 Luncheon Recess.

2:00 Convergence & Accommodation Responses at and Beyond the Apparent Amplitude of Accommodation in Incipient and Advanced Presbyopia.
Max Schapero, O.D., Los Angeles College of Optometry, Los Angeles, California.
Melvin Nadell, O.D., Ph.D., Los Angeles College of Optometry, Los Angeles, California.

2:30 Discussion.

2:40 Additional Aspects of Blurring and Color Discrimination.
Arthur Shlaifer, O.D., Ph.D., Pennsylvania State College of Optometry, Philadelphia, Pa.

2:55 Discussion.

3:05 Meeting of the Educational Needs of the Partially Sighted.
Alfred A. Rosenbloom, O.D., M. Sc., Illinois Colleg of Optometry, Chicago, Illinois.

3:40 Discussion.

4:00 Business Meeting.
John D. Perry, Jr., O.D., Presiding.

6:00 Cocktail Hour.

7:00 Annual Roundtable Dinner.
Meredith W. Morgan, Jr., O.D., Ph.D., School of Optometry, University of California, Berkeley, California.

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Tuesday, December 11, 1956

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9:00 Section Meetings.

11:10 Cosmetic Aspects of Ophthalmic Lenses.
Margaret S. Dowaliby, O.D., Los Angeles College of Optometry, Los Angeles, California.

11:30 Discussion.

11:40 The Effect of Measles on the Development of Myopia.
Monroe J. Hirsch, O.D., Ph.D., Ojai, California.

12:10 Discussion.

12:20 Luncheon Recess.

1:45 Procedure and Results in Some Visual Training Cases.
John Zettel, Jr., O.D., Cincinnati, Ohio.

2:05 Discussion.

2:10 An Automatic Focusing Device for Ophthalmic Lenses.
Donald B. Whitney, Product Engineering Manager, Lens Division, American Optical Company, Southbridge, Massachusetts.

2:30 Discussion.

2:40 A Survey of Results from Visual Training and Orthoptics in Office Practice.
Daniel Woolf, O.D., Ph.D., New York, New York.

3:00 Discussion.

3:10 The Optics of Plano Lenses.
John K. Davis, A.B., Head, Ophthalmic Optics Section, American Optical Company, Southbridge, Massachusetts.

3:30 Discussion.

3:40 The Effects of Duration and Background Luminance Upon the Brightness Discrimination of an Amblyope.
Theodore Grosvenor, O.D., Ph.D., College of Optometry, University of Houston, Houston, Texas.

4:10 Discussion.

4:20 Vision and Rapid Reading.
Howard N. Walton, O.D., M.S., Los Angeles College of Optometry, Los Angeles, California.

4:35 Discussion.

CURRENT COMMENTS

Terry Judith Parkins
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department; such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

THE SHEARD VOLUME

The Joint Committee working on this project reports that the page proofs for most of this large volume are now in the author's hands for his final approval. The book is being published for the Committee by the Chilton Company of Philadelphia.

The Committee had hoped to have this book completed by this time, but the final corrected galley proofs were not received until late in September. These corrections have now been type set, and the material is nearly all paged. The volume should be off the press shortly, and we are sure that those of our readers who sponsored the *Sheard Volume* with advance orders will be pleased with its appearance and contents. The publishers are doing a nice job and the Committee who has been proofreading the material (Sheard, Hirsch and Morgan) have been most thorough. The project has been a pleasure for all concerned and the author has been most cooperative and helpful. The Committee is composed of optometrists, ophthalmologists and opticians and the book will express for everyone in ophthalmic optics the affection for Dr. Charles Sheard who did so much to lay the foundations for modern refraction.

I-GARD PLASTIC HYPEROCULAR SPECTACLE MAGNIFIERS

A new set of aids for the correction of subnormal vision has been introduced. These are the I-Gard aspherical magnifiers. These are lenticular lenses of 4X, 6X, and 8X powers and are worn monocularly in a spectacle frame of special design. The aspherical curvatures of the lenses permit larger magnification with minimum sacrifice of field and definition. Critical reading distance is controlled by "distancing post" fitted to the frame and against which the reading matter is held. Other advantages of I-Gard hyperoculars are extreme weight (the 8X lens weighs less than ⅓ oz.), shatterproof protection, and improved appearance, as the lenses can be glazed to cosmetic size. Literature and testing sets are available from McLeod Optical Company, Inc., 357 Westminster Ave., Providence, Rhode Island.

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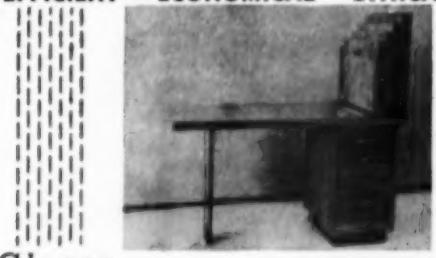

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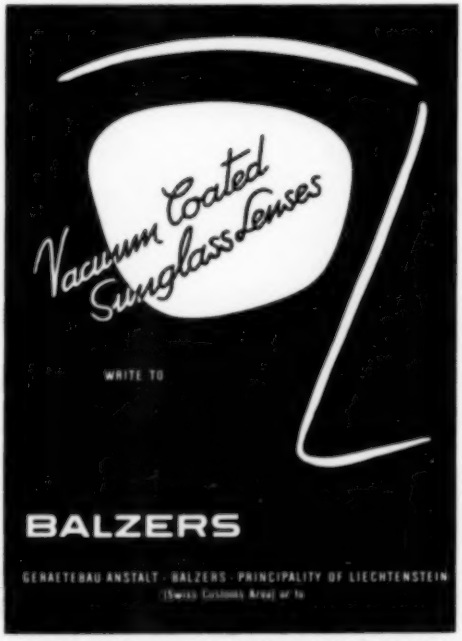
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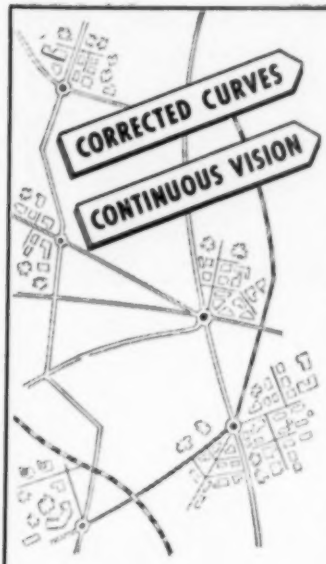

Where do the roads of ophthalmic progress lead?

Scientific progress shows the right roads ahead more clearly with each passing year. This has been particularly true in the ophthalmic field. Those laboratories which have used only the quality products of the progressive manufacturer have found that they benefit and build both themselves and the doctors whom they serve.

This has certainly been true in the case of corrected curve lenses. Progressive laboratories everywhere stress their use—and they mean even more to the doctor and his patients. We lend our voice strongly to this suggestion. It is our firm belief that we serve better by supporting such recommendations.

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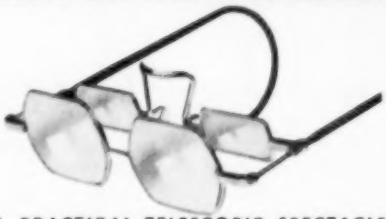

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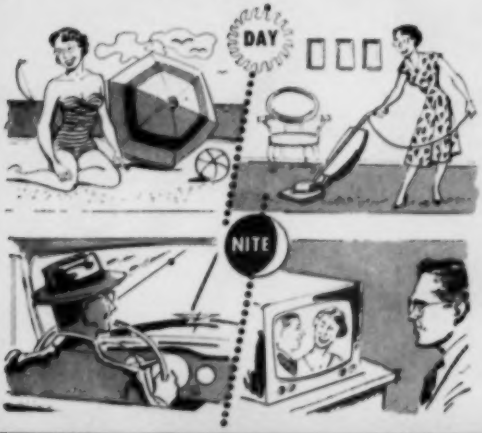

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